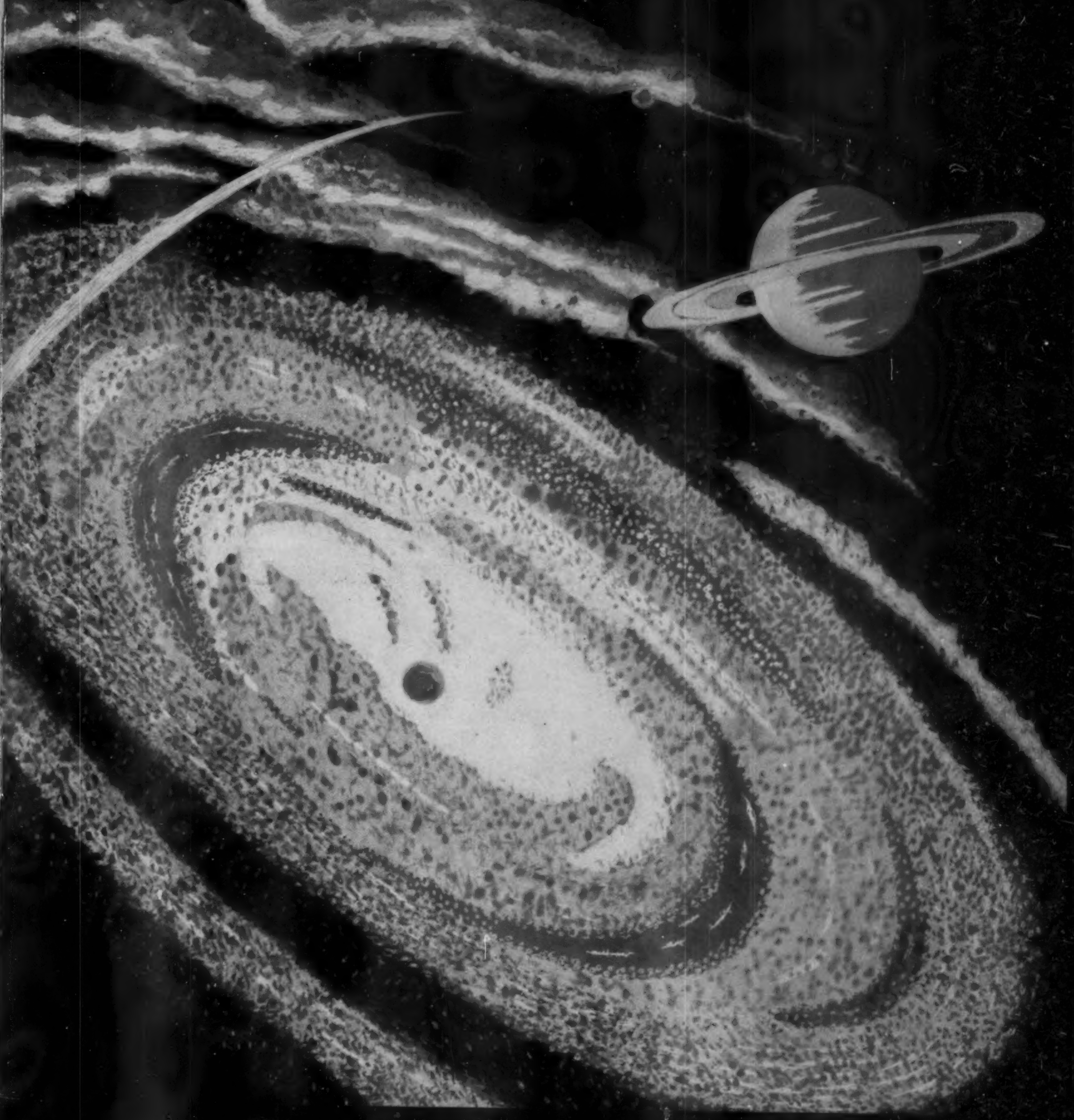
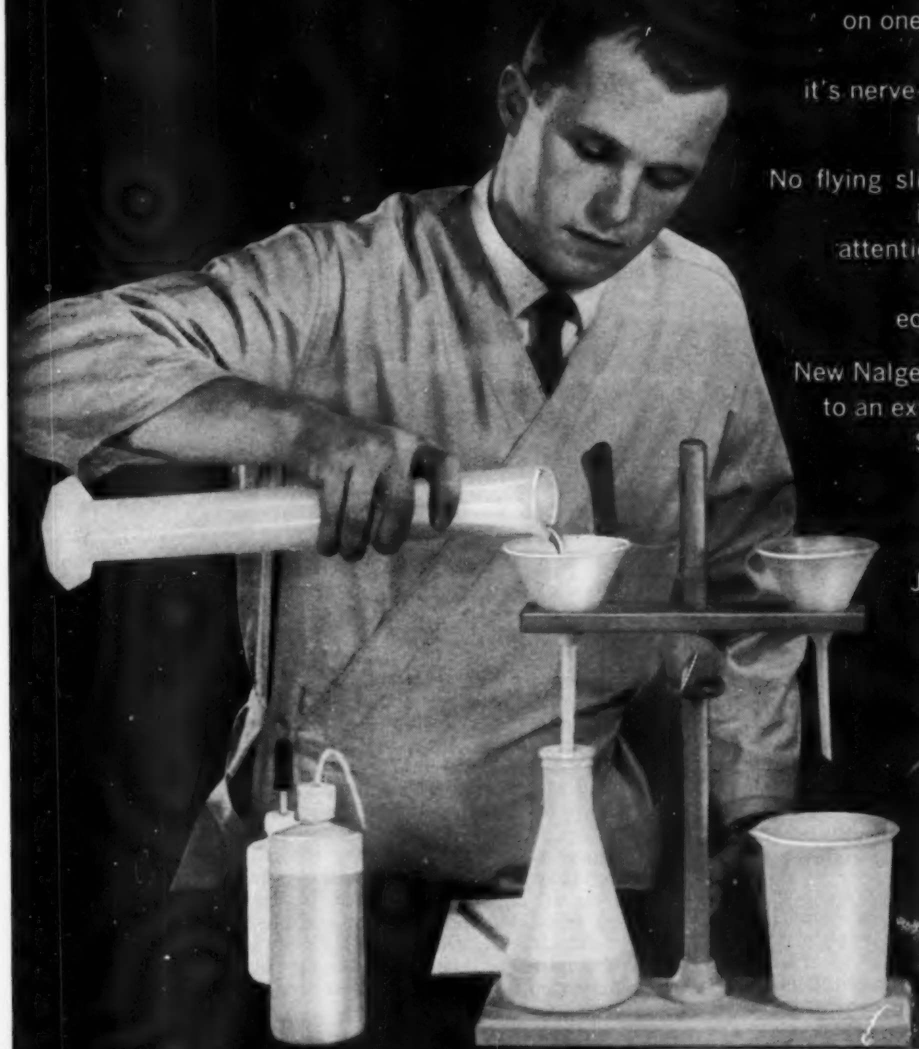
THE SCIENCE TEACHER

VOLUME 28, NUMBER 4 · MAY 1961





THE SCIENCE TEACHER

The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

Journal of the National Science Teachers Association
Volume 28, Number 4 • May 1961

Editorial

A Salute to Science Teacher Leadership

Rich, rewarding, and reassuring sentiments are difficult to convey. Yet, if each fellow science teacher could have traveled across 10,000 miles of the country with me and met with several thousand NSTA members, then indeed we could share mutual feelings derived from our similar experiences. From meetings in small rural schools to large sophisticated urban conclaves, one factor was obvious—progress. Teachers endeavored to learn about new advances in science teaching, to increase their backgrounds, and to move on with curricular developments. The opportunities offered by the National Science Foundation and industry-sponsored teacher institutes served as a catalyst to advance interest in the growth of our profession. Yet, it is to the credit of individual teachers that they have taken the initiative and made an effort to establish fundamental improvements in their profession.

Examine with me a few of the outstanding examples of our progress in science education. Probably the most exciting and important developments have occurred in the NSF-sponsored research of our course offerings. Such work as produced by the Biological Sciences Curriculum Study, the Chemical Education Material Study, the Chemical Bond Approach Project, the Physical Science Study Committee, and advanced studies in the earth sciences and mathematics will bring the newest advances in subject matter along with the best in methods to the door of every classroom. Not only the remarkable results produced by such studies, but also realistic grounds for optimism are found as college professors and secondary school teachers work together in these essential areas. Together they open new avenues of cooperation and understanding pointing toward a bright future in science education.

These new developments, however, will remain at the classroom door unless the teachers are able to utilize them. Too many teachers find themselves in situations where excessive work loads preclude adequate attention to research into curricular development. It is essential that school officials and the public realize that genuine progress will result only when the teacher is permitted to exercise his training, experience, and intelligence in a creative climate.

Alan T. Waterman, Director of the National Science Foundation, says, "It must be admitted that as a people and a Nation we have not been properly appreciative of intellectual achievement. This awareness and appreciation is not something the Government can legislate into being. We must build it into our national consciousness through our educational system, and until we do, science and all other forms of intellectual activity will lack the firm foundation they require." This awareness and appreciation whereof Dr. Waterman speaks can only be achieved by the catalytic action which occurs through teacher leadership.

Fortunately, many teachers already realize that the opportunity to initiate leadership is directly reflected by the increased pulse of activities in our national organization. A growing and active membership has resulted in establishing such an outstanding program as the Future Scientists of America. The influence of the American science teacher is beginning to be felt in other countries through the developing international scope of NSTA. The experiences of this year have served to strengthen my conviction that the science teacher is vital to our way of life; he must be encouraged and assisted in every way possible.

As this year comes to a close, I wish to thank the membership for making it possible for me to serve as your president. I know you join me in welcoming to office the new president, J. Darrell Barnard.

ROBERT A. RICE
President, NSTA (1960-61)

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MEMBERSHIP

The membership year extends for one year from date of enrollment. Subscriptions are entered for either the calendar year or the school year.

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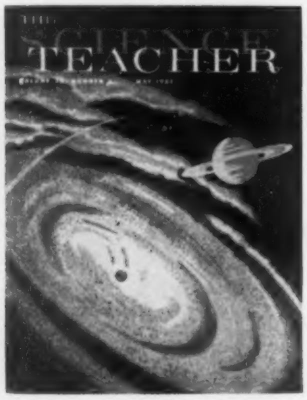


THIS MONTH'S COVER . . .

What are the conditions in outer space? What lies between our universe and the stars or planets that surround it? The atmosphere is rich in wonder and knowledge. It offers a fertile environment for philosopher, scientist, artist, or dreamer. It provokes the inner mind of child or adult as he ponders on the mysteries of the galaxies.

In the lead article (page 6), Dr. Bancroft Sitterly, physicist and astronomer, describes the environment of a spaceman in a "typical" region within our galaxy.

The drawing is from a reprint slide made available and reproduced by permission of the U.S. Navy.

Beware of Rockhounds

The public schools face many problems connected with the rapid increase in the number of America's rockhound population. Most school teachers are onlookers as thousands of rockhounds learn on their own initiative and take mineralogy courses by television from outstanding museums such as the Oregon Museum of Science and Industry in Portland, Oregon.

These gregarious and articulate rockhounds may actually invade the nation's schools before teachers are ready for them. Once a classroom becomes invaded, a teacher is forced to play the tragic role of a silent onlooker as the rockhound coyly reveals his diamond, or fossil, or petrified snail to a captive audience. Children often catch the rockhound fever and revel in the joys of self-instruction and freedom from the pedagogical strait jacket. Or, worse yet, they may turn on their teacher and terrify her with such questions as "What makes emeralds green?" "Why are quartz crystals hexagonal?" or "How can you tell the age of this fossil?"

Perhaps the following warning should be posted in teachers' lounges: "Beware of rockhounds and rockhound fever; both are fatal to teachers who have not been inoculated with the academic virus of earth science, mineralogy, geology, or time-tested physical geography."

JOHN SHAFFER
State University of New York
Cortland, New York

A Personal for the Executive Secretary

I have arrived back in Australia and wish to thank those who helped particularly in making my year's leave and stay in America such a pleasant experience. Your assistance in driving me to a motel outside Princeton began a wonderful few days, especially when Dr. Hubert Alyea contributed his hospitality by taking me to his own comfortable home on the campus for the rest of my stay. He is a man after my own heart—thoroughly enthusiastic about the teaching of science and its improvement! From there began visits to Harvard, Brown, Massachusetts Institute of Technology, and Phillips Academy at Exeter. Then went to Chicago and visited educational environs at all levels, then to the majority of the "Big Ten" universities. Finally off to Phoenix, Arizona, and the Grand Canyon as a respite from over-indulgence in chemistry. Recuperated, I spent the remainder of my time in California where again I saw all the top institutions at secondary and tertiary level.

The books and pamphlets you sent me arrived safely and were well used at a summer school just concluded for 130 science teachers. I had also both the CBA and the CHEM Study books and am still not quite sure whether they caused more alarm or delight! Much of our science teaching is old-fashioned and traditional, and I could wish for a magic carpet to transport half a dozen or so of the men I met in the USA to help in transforming it.

J. J. BROE
School of Chemistry
University of Sydney
New South Wales, Australia

EDITOR'S NOTE: As part of his leave of absence, Professor Broe came to visit colleges and universities and secondary schools to meet and talk with leaders in science education.

We are honored that one of his first stops was NSTA Headquarters in order to find out about our Association and to obtain help in arranging final details of his study tour. We hope for future visits.

From Reader to Author

I should be interested to know if you have not omitted three possible answers in the sample examination in the article "Teaching Three Dimensions in Biology" (*The Science Teacher,* February 1961).

On page 8, Problem II, part 2, you give "B" as the only answer. How about "C" (by cutting a vertical plane through any diameter of the cylinder) and "D" (by cutting a plane vertically through the equator of the sphere)? In part 3 of the same problem you give "C" and "E" as answers. Why not "F" also (by cutting a horizontal plane through the hollow cylinder)?

The article was informative, and I think will prove useful to me and to other science teachers. Three-dimensional comprehension is difficult to teach, and you have certainly presented a clear cut method of getting started in learning three-dimensional visualization.

JOHN DREYFUSS
Robert Louis
Stevenson School
Pebble Beach, California

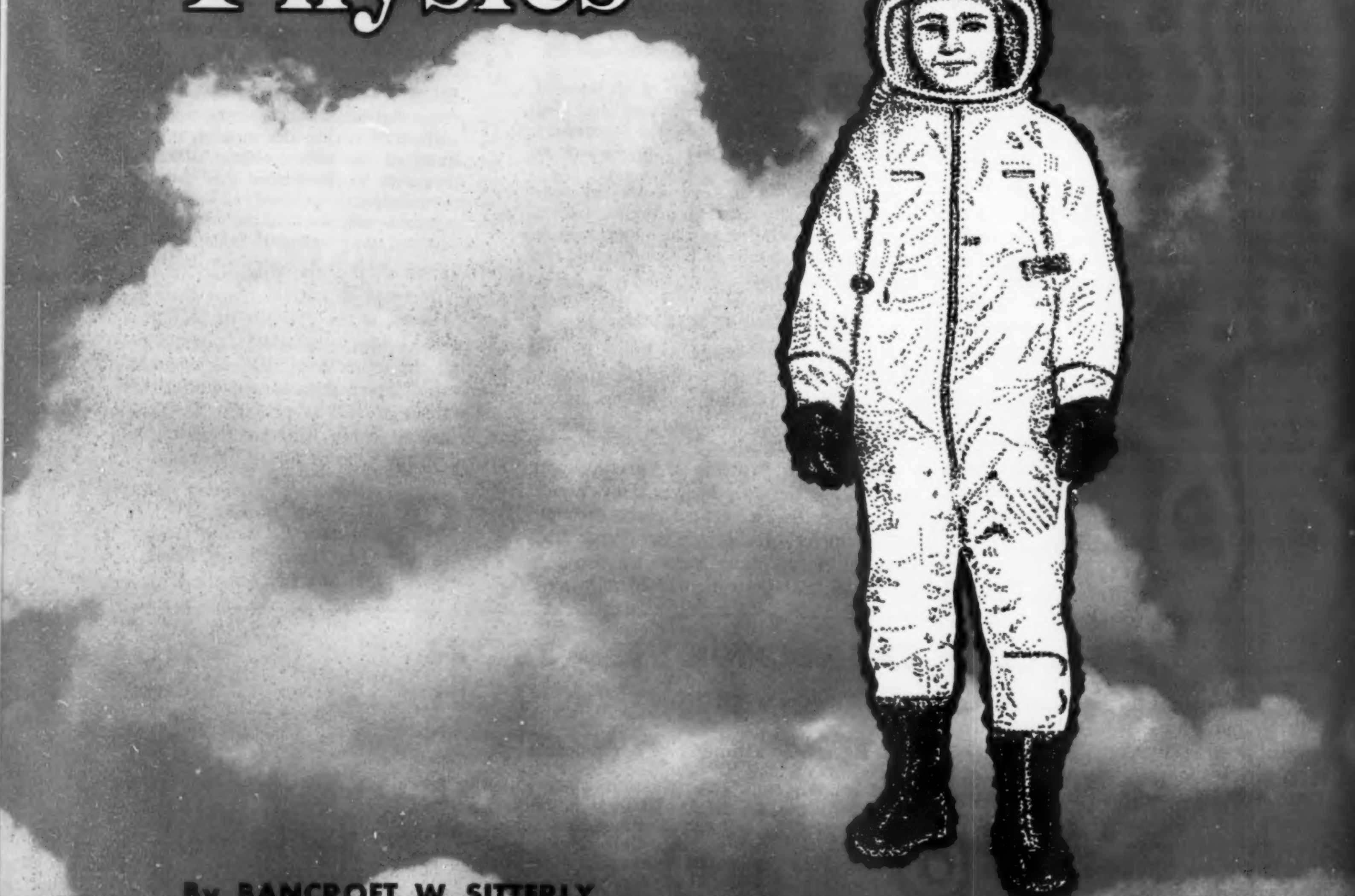
Your interest in the "3-D" article is appreciated. I have re-examined the questions which you raised, and in terms of our own interpretation of what we have said or think we have said, the answers you suggest would not be correct. First, let me point out that it was our intention for the problem to be limited as follows:

1. ". . . a slice cut with parallel lines in any one plane were cut from any plane through object." This is meant to limit the problem to a single cut.
2. ". . . the outlines below represent the surface of a slice cut through one or more of the above objects." This is meant to be interpreted that the outlines below, numbered 1, 2, 3, etc., represent only the slice cut and not any exposed surface other than the one cut.

In terms of the above limitations, we would interpret a vertical plane through any diameter at the cylinder of "C" as a rectangle and a vertical plane cut through the equator of "D" as a circle. We would interpret cutting a horizontal plane through "F" as providing a circle as illustrated in No. 4 or a vertical cut as providing the type of figure illustrated in No. 7.

ADDISON E. LEE
Science Education Center
The University of Texas
Austin 12, Texas

The Spaceman's Physics



By BANCROFT W. SITTERLY

Professor of Physics, The American University, Washington, D.C.

PHYSICS is a method by which we understand and deal with our experience. As such, the basic concepts depend, to a larger extent than is realized, upon the fact that we live on the surface of a medium-sized planet located at a medium distance from a medium-sized star. In physics, as students are introduced to it the most prominent force-across-a-distance is the earth's gravity, so that *g* is the first physical constant that a beginning student learns. Currently, matter is typically organized into rigid bodies, liquid aggregates, and gases of density comparable to that of the base of the atmosphere. The balance between incoming and outgoing radiant energy at the earth's surface keeps earth temperatures near that range within which water under atmospheric pressure is a liquid. Matter is considered to be habitually inert, electrically neutral, and magnetically unpolarized. "Electricity" originally meant "the peculiarity of rubbed amber" and "magnetism" meant "a wonder reported from that remote region, Magnesia." In elementary physics courses, falls and collisions are the happenings first investigated.

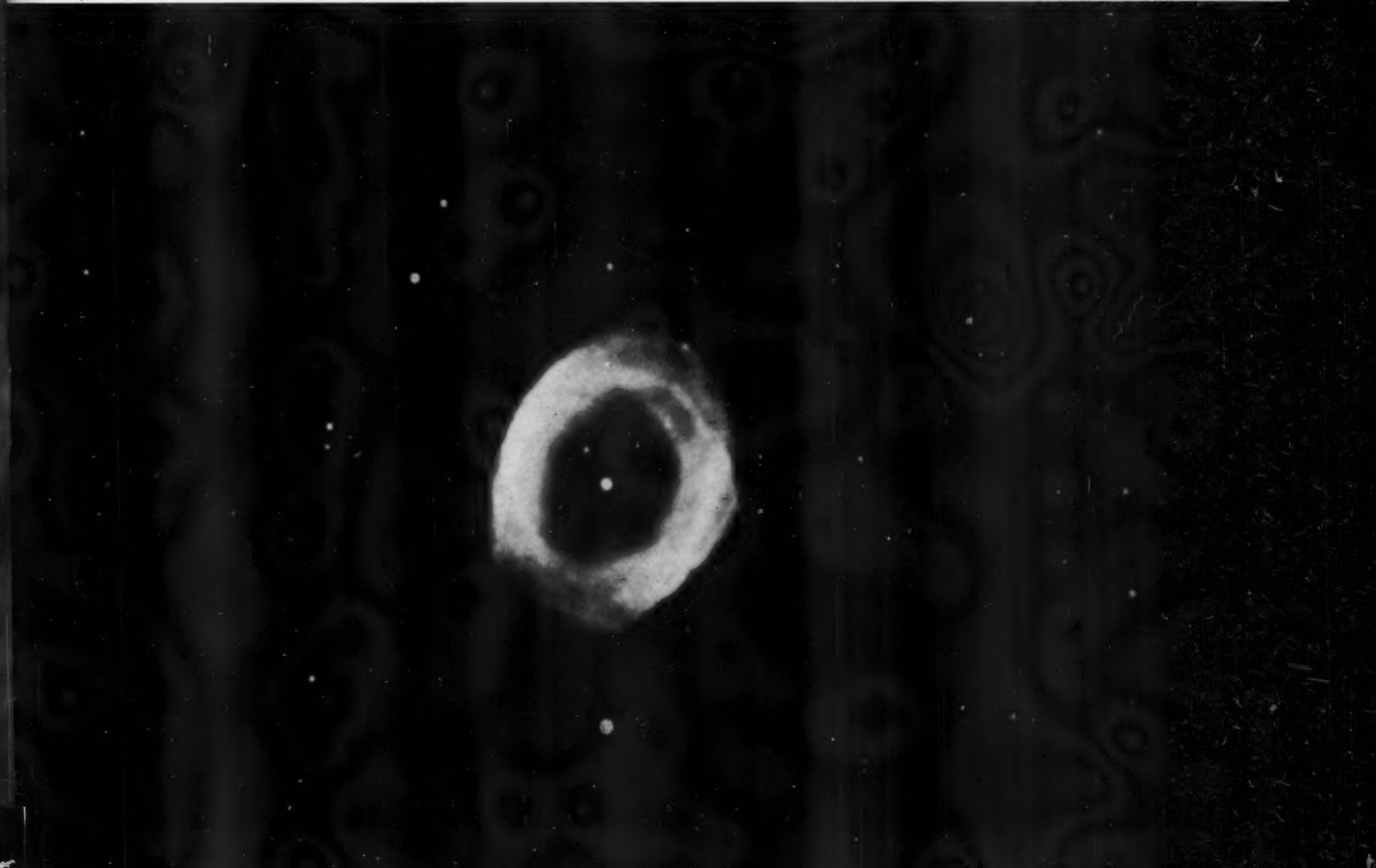
These conditions are in fact *exceptional* in the universe at large. Consequently, it may be profitable for a student (or teacher) of physics to ask how physics would appear to an intelligent observer who examines his surroundings in a location far removed from earth's familiar environment. What characteristics of matter would an inquiring spaceman find most noteworthy?

Let us place our spaceman first in a "typical" region within our galaxy, but neither in its central region nor near its edge, among the stars but not in the immediate neighborhood of one. At first he will consider himself to be in a complete vacuum, aware only of the weak radiation from the distant stars surrounding him. Actually he will be surrounded by matter, dust grains, free atoms, and an occasional simple molecule, forming an almost inconceivably tenuous cloud extending indefinitely in all directions. The atoms are mostly those of hydrogen, but traces of the commonest light elements, such as carbon, nitrogen, oxygen, sodium, calcium, titanium, and iron, and more than a trace of helium, are present. They are spaced on the average about half an *inch* apart, and in this gas an atom will commonly travel for a *week* between successive collisions with other atoms. The most frequent diameter of a dust particle is perhaps a micron (1/25,000 inch) and the distance between adjacent grains approximates a quarter *mile*. Among the atoms and dust, the ions that are known as primary cosmic rays streak in all directions at speeds approaching that of the velocity of light.

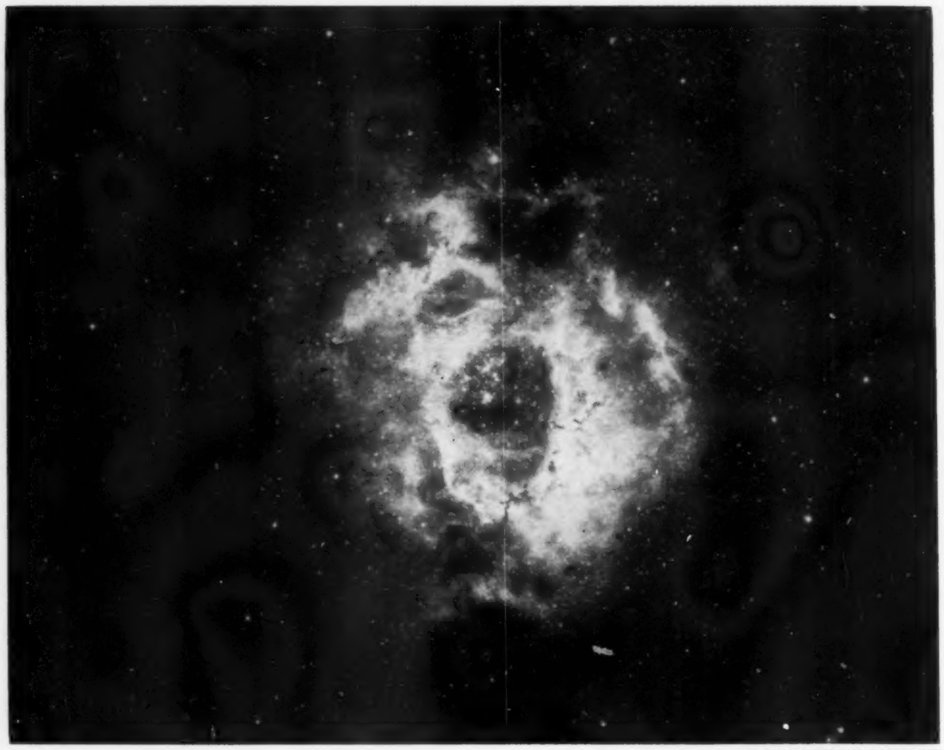
In such highly dispersed matter, mechanical activity and thermal phenomena do not appear as they do in terrestrial laboratories. The behavior of the atoms depends more on their individual absorption and re-emission of the radiant energy from the distant stars than on the atoms' encounters with their neighbors. Insofar as the atoms may be said to have a temperature, it is defined by the distribution of their velocities. It is estimated that around our spaceman atomic temperatures may average halfway between

The Ring Nebula, *Lyra*—a "hot star," illuminates a gas cloud.

MOUNT WILSON OBSERVATORY



Centigrade zero and Absolute zero. The spaceman's thermometer, however, will not show this. The reading of the thermometer will indicate the temperature at which it absorbs and re-radiates energy equally; here this temperature will be about 3°C above Absolute zero, or -270°C. This will also be the temperature of the dust grains. As for mechanical forces prevailing in these depths of space, of course the gravitational attraction of even neighboring grains on each other is inappreciable. A weak gravitational field does exist, due to the vast mass of the galaxy as a whole, and under this the entire medium, gas and dust, sweeps around the galactic center in a gigantic orbit. The speed of this motion is high (in the solar neighborhood it is nearly 200 miles a second) and it varies with distance from the center, so eddies on a grand scale will occur because of shear between regions of different speeds. Other forces are appreciable, though also weak. Particles as small as these are perceptibly accelerated by absorbing momentum from radiation they intercept. Moreover, this radiation will ionize a small fraction of the free atoms, and the ions and electrons formed will each possess a minute electric field and, because it is moving, a minute magnetic field. The magnetic field in turn will divert other charged particles in motion. Though deep space is no region for studying the behaviors that Galileo, Huygens, Hooke, and Newton made intelligible, it is a natural laboratory for atomic physicists.



NATIONAL GEOGRAPHIC SOCIETY

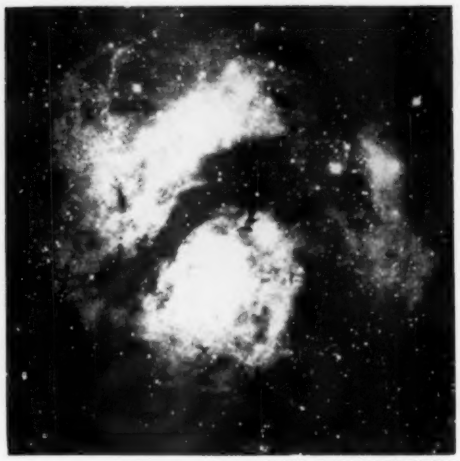
The "Rosette" Nebula, a glowing cloud excited to shine by "hot stars." Note dark streaks of dust silhouetted on the glow. The Milky Way stars seen are mostly in front of the nebula.

Andromeda Galaxy, an island universe of stars so clustered together that it blazes like a whirling Fourth-of-July pinwheel. It is considered a twin of the Milky Way Galaxy that holds the earth and its sun. The two bright objects outside the spiral itself are dwarf satellite galaxies which accompany Andromeda.

NATIONAL GEOGRAPHIC SOCIETY—PALOMAR OBSERVATORY SKY SURVEY

If our spaceman tranfers himself to another region, within a few light-years of a really "hot star" (but still remains far outside the reaches of its planetary system), he will find a change in the character of the tenuous medium surrounding him. Here radiation is still weak, and comes largely from stars at great distances all around, but the "hot star" supplies a uni-directional component of this, differing from the rest in that it is predominently at ultraviolet frequencies. The effect of this is almost completely to ionize the free atoms in space. They become not a classical gas but a plasma. Electrical forces now control individual encounters, and though mixing of the freed electrons and the positive ions washes out any general electric field, turbulent motions in the plasma may result in perceptible magnetic fields. The encounter with an ultraviolet quantum of radiation that ionizes an atom powerfully accelerates the resulting ion and electron, so that individual random particle speeds in the plasma correspond to a temperature of 10,000°C or more (but the surfaces of dust grains are still near Absolute zero). Also the radiation pressure from the "hot star" pushes the whole medium outward. An extremely faint glow pervades the region. It is emitted by the ions as their still-attached electrons settle down into stable configurations after the disturbances produced when they intercept radiant energy. The spaceman cannot perceive it immediately around him, but the enormous extent of the surrounding clouds provide enough glow to render his sky very faintly luminous. Looking at him from our own earth, we see that he is in an extended nebula.

Our spaceman's interest may next be transferred to the "hot star" itself—undeniably an identifiable physical object, quite different from a grain or an atom, and the only kind of object that he can really see anywhere near him. He now approaches this closely (with suitable protection) and examines it by all available means. Once more, he finds it unearthly. From the very small he has gone over to the very large, from



MOUNT WILSON OBSERVATORY

Dark gases obscure the "hot stars" in this area—the Nebula M-8, referred to as *Sagittarius*.

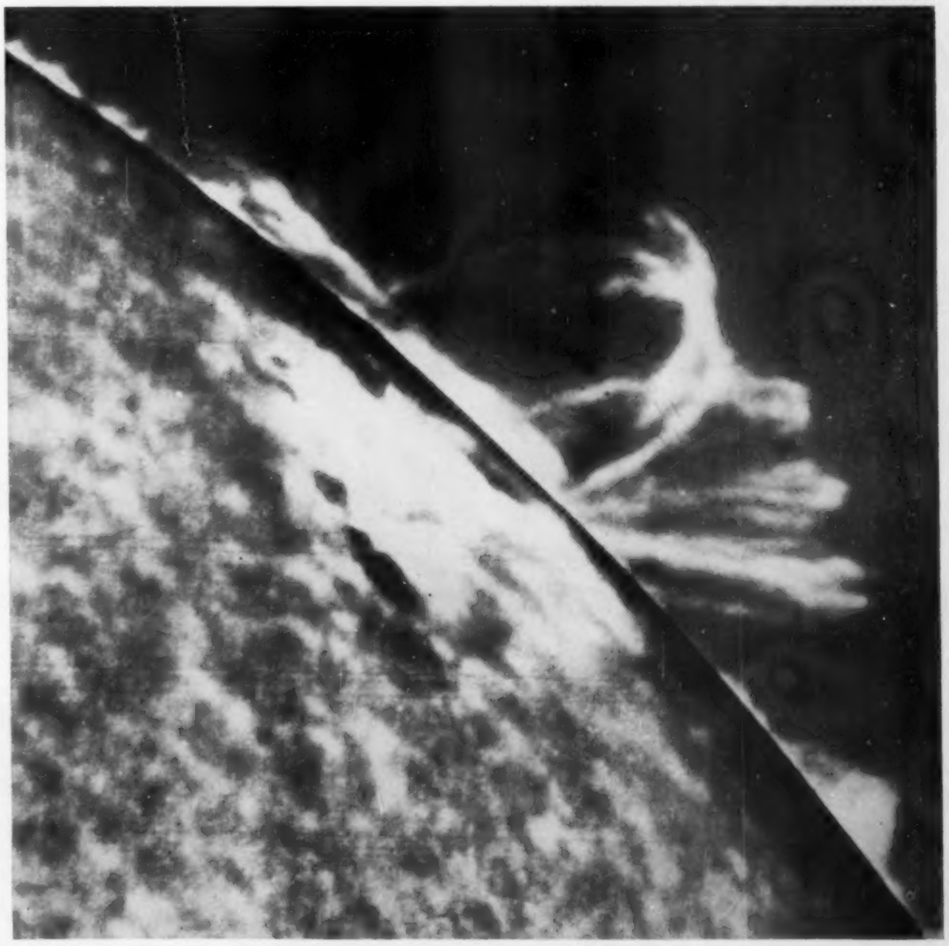
low to extremely high temperatures, from near darkness to blinding radiance. The star is an object, but its material is not terrestrial matter in any ordinary form. It is closely packed, except near the star's visible surface (which is not really a surface but a layer between opaque and transparent regions of the star). The star contains as much matter as does a region of deep space perhaps fifty light-years on a side; the major part of this matter is compressed to a density greater than that of solid iron. Yet no part of the star is solid, or even liquid; it is all gaseous, and all except an extremely tiny fraction, monatomic plasma—a mixture of free electrons and completely or nearly stripped nuclei—nuclei of the same elements that our spaceman found in "empty" space. The radius of a nucleus is so very much less than that of an atom with all its electrons that nuclei may be forced together until their separation is a small fraction of an atomic radius, and there is still enough room between them. The temperature through most of the star is more than a million degrees Centigrade, and between the particles there is a constant flow of radiation of extreme intensity and frequency, predominantly in the extreme ultraviolet and X-ray regions.

In these conditions the spaceman at last recognizes something familiar. He is investigating a supercolossal thermonuclear reactor. The central region of the star is the core. The outer regions are at the same time the shielding, the heat exchanger, and the moderator. The structural principle is simple. Gravitation holds the mass together; gas pressure and radiation pressure hold it apart. The point of balance depends on the temperature. If the energy production increases, the temperature rises, and so does the pressure. This expands the star, and the expansion lowers the temperature, decreasing the energy production, which also depends on the temperature. In turn, the pressure drops, the star contracts, and temperature and energy production again increase. The alternation is self-damping in this case—evidently so, for the star is in fact stable. Energy from the core is passed to the surface partly by radiation from ion to ion, partly by a convective layer of ascending and descending streams of plasma. The whole star rotates, but with a systematic turbulence that is not clearly understood yet, and involves not only the mechanics of the plasma, but the interaction of the magnetic fields generated by its motion. At the star's surface, the density of the matter becomes very low, the gravitational force moderate, and the intense radiation takes over. The upper stellar atmosphere is in violent turbulent motion of a very complex sort, but with a strong outward trend, so that ions and electrons are projected away from the star with very high speeds. A star of this sort may have an expanding envelope, many times larger than the star, visible at great distances.

Such, then, is a star. Such is our own sun, though it is not as large or hot as the one our spaceman has examined, and does not energize a vast region of space to glow. Of all the matter in the universe as now known, it is thought that nearly half is organized into stars, and most of the other half is gas and dust clouds of the kind first described, though many of the clouds are much denser than these. Fortunately, there is a bit left over to make up bodies like the earth, on the surface of which, if he finds one, our spaceman may study an *earthman's* physics.

An edge of the sun discloses violent turbulence; prominence and a sun spot shown.

YERKES OBSERVATORY



AN NSTA COMMITTEE REPORT . . .

PART I
Mission to Glasgow and London

JANUARY 1, 1961 THROUGH JANUARY 17, 1961

MEMBERS of the delegation to Glasgow and London were Robert H. Carleton, Executive Secretary of NSTA; Ralph E. Keirstead, State Department of Education, Hartford, Connecticut; Abraham Raskin, Hunter College, New York City; Fred R. Schlessinger, The Ohio State University, Columbus; and Zachariah Subarsky, The Bronx High School of Science, New York City.

The mission undertaken by the NSTA group was financed by the Association with added support from the National Science Foundation. The total expense amounted to approximately $3300 and of this amount $2500 was provided by NSF.

Purposes

Why did the National Science Teachers Association decide to sponsor and provide partial support for this project in international activities?

Perhaps the answer to this question may be clarified by examining the statement of purposes of NSTA's Committee on International Activities.

"To initiate, foster, and promote activities on the part of the Association, its members, and science students that will have the following purposes:

1. To gain a knowledge and understanding of the objectives, problems, culture, and job realities of our counterparts abroad.
2. To transmit to our friends abroad a knowledge of our own situation culturally and professionally.
3. To work cooperatively with our colleagues abroad toward the solution of common problems.
4. To apply directly in our own situations the best of what we see abroad in methods, materials, and facilities.
5. To provide direct professional assistance to groups temporarily less fortunate than ourselves.
6. To provide opportunities for science teachers to profit inspirationally from visits to such scientific shrines as the Cavendish Laboratories at Cambridge, the Pasteur Institute, and the Joliot-Curie Laboratories.
7. To provide opportunities for science teachers to add to their intellectual capital through visits to such establishments as the giant radiotelescope at Jodrell Bank, the European Center for Nuclear Research at Meyrin, and the Delta Plan in Rotterdam.
8. To broadcast our new knowledge and understandings to our fellows here in the United States through our journals and by word of mouth."

The Science Masters' Association (SMA) meetings at Glasgow; the meetings at the Ministry of Education in London with science education leaders from England, Nigeria, Bahrain, India, and Iran; the visits to Dulwich College, Kingsdale School, Hatfield School, The Royal Grammar School at High Wycombe, Cambridge University; and to the headquarters of the SMA at Cambridge provided us constant opportunity to work toward the attainment of the first three objectives. Through these experiences, each of our group is able to give representative views of the benefit and effect produced as a result of the exchanges with others. This report represents an effort in which the group may disseminate the new knowledge and understanding derived from our participation with the international community.

Preparation of the Science Master

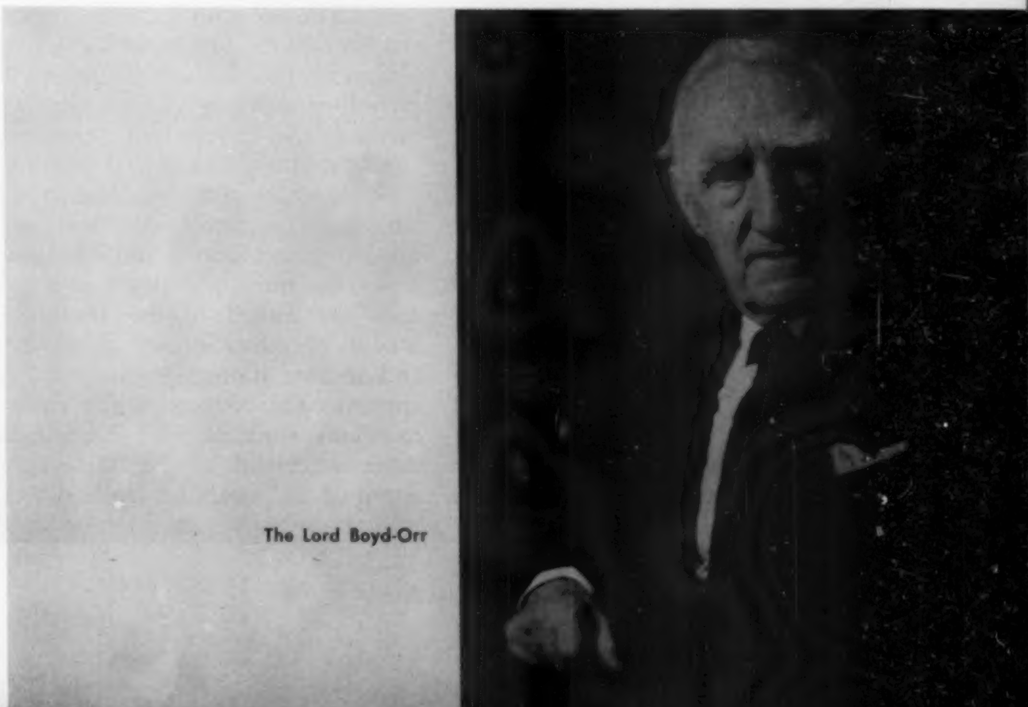
Great Britain, similar to the United States, is currently suffering from a dearth of teachers. The most serious shortages are in the fields of science, mathematics, physical education, domestic science, and handicrafts.

The science masters we met both at the Glasgow meeting and at the various schools visited were, in general, well prepared. Many, particularly those who taught in the grammar schools, were graduates of Oxford or Cambridge with "firsts" in their fields of specialization. The dedication and interest of most of these teachers were more evident here, particularly to one who fears that the profession of the secondary school teacher is degenerating into an attitude of "just another job" in his part of the country. At the schools visited, teachers worked with such equipment and facilities that we would term in the U.S. as average. The class size in general compares to ours. The teaching load, however, is considerably heavier. At High Wycombe, a first-rate grammar school, some of the science masters were teaching a total of thirty-five hours a week. We might assume that this is not uncommon in other areas.

How does one become a science master?

An individual seeking a career as a teacher of science in a publicly-aided school in England or Wales must be approved as "qualified" by the Ministry of Education. To achieve this status, he must first graduate from a secondary school. The would-be teacher may then elect to attend a university or he may decide to study at a training college.

If he chooses to be a prospective teacher of science, in chemistry, he takes a program of studies at one of the seventeen universities in England and Wales. The program is precisely the same as the one taken by a would-be chemist. Both will study the classics, other areas in the humanities, the social sciences, chemistry, and other natural sciences and mathematics. Neither will take courses in education. At the conclusion of this university program, the graduate is declared as "qualified," and he may proceed to find employment in a secondary school.



The Lord Boyd-Orr

Colin Campbell (extreme right) of Moray Teachers College in Edinburgh served as SMA host at our dormitory. The group enjoys a late tea break after an evening session. During the SMA meetings, breaks for tea twice a day were observed standard practices.

He may prepare himself further by taking a postgraduate year in education at a university. These programs are generally supervised by area training organizations.

The program at the University of London for the Postgraduate Certificate (formerly the Teacher's Diploma) extends over one academic year. Applicants must be university graduates, and, as a general rule, must have taken an accepted honors degree.

The regulations require students to take courses leading to an examination in the following subjects:

1. Principles of Education.
2. Special Methods.
3. Psychology and Health Education.
4. The Present Educational System of England and its recent history.
5. Psychology at a level higher than in 3, *or* Comparative Education and Administration, *or* Development of Education in Tropical Areas.
6. Practical Training in Teaching.

Optional courses, largely in the humanities, may also be taken during the year.

The University of London also offers both the MA and PhD degree in Education.

If the secondary school graduate finds it difficult to obtain a place in a university or for some other reason decides not to attend a university, he may become a "qualified" teacher by attending one of the 155 training colleges in England and Wales. Many more of these are now being built. Scotland has its own Ministry of Education, school inspectors, and teacher training program which, incidentally, *requires* a year of professional training in a Department of Education. Local schools in Scotland do share in receipt of supporting funds from the British Ministry of Education, however, as do other schools in the United Kingdom.

In England and Wales, the training college course normally lasts three years. The program includes studies in the liberal arts, in special subject matter areas, in the mental and physical growth of children, and in educational methods and observations, and supervised teaching. The period of training may be shortened for older persons who have specialist qualifications in art, handicraft, music, and other areas.

All the training colleges in a given area are linked to the institute or school of education of a university and an area training organization that approves the courses at the colleges, examines students, and recommends those successful to the Ministry for approval as "qualified teachers." The area training organization generally consists of representatives from the university and its department of education, the training colleges, and local education authorities.

The Ministry of Education is the only organization which certifies that a teacher is "qualified." It can also withdraw the "qualification" for sufficient reasons. The Minister, like our own accrediting organizations, is currently hard pressed to find a sufficient number of properly qualified teachers of science. He has therefore opened other paths to qualification in addition to the normal demands; *i.e.*, approved courses of training. A long period of satisfactory service as a non-qualified teacher or graduate membership in certain scientific institutes are two of the alternate routes to qualification.

"Qualified" teachers are required to serve a probationary period during which they "may be required to satisfy the Minister of their practical proficiency." This period is generally for one year, but it may be extended or waived entirely.

The Minister has also approved the employment of temporary teachers, generally for periods of two years. Temporary teachers may be in the process of preparing for qualification or may have failed to complete a course of teacher training satisfactorily. For the latter group, this represents an opportunity to retrieve their failure.

As in the United States, scholarships of various kinds are available for prospective teachers. Those attending the training colleges may receive financial help to cover the cost of tuition, board and lodging, traveling, and other personal expenses in accordance with their own or their parents' means. Students attending universities may obtain scholarships offered by the Ministry of Education, local education authorities, or by the universities themselves. More than three-quarters of the students at English and Welsh universities receive some form of financial assistance.

Finding a Job

The path to employment and to advancement for British science masters is generally the same as for science teachers in this country. They may apply for positions as teachers, as heads of department or principal science masters, or as headmasters of

schools. Science masters are made aware of such opportunities through advertisements by various educational authorities in the weekly educational supplement of *The Times,* or in professional journals, or by recommendations. The variety of these positions was amazing to us. Here are a few examples culled from advertisements in *The Schoolmaster and Woman Teachers' Chronicle* (Journal of the National Union of Teachers):

> "Qualified mistress to offer two or more of the following subjects: General Science, Music, Art, Religious Knowledge."
>
> "Vice Principal, Liverpool Collegiate School"; "Cookery mistress."
>
> "Master or mistress to take general subjects with an interest in teaching slower groups."
>
> "The Authority is looking for a man with a progressive outlook, interested in simple woodwork and prepared to help with the school poultry club."

There seems to be no end to the variety of positions, or to the inducement offered. Here are some typical inducements:

> "The new school building is situated on a delightful dale-side."
>
> "The school offers up-to-date facilities . . . two fully equipped laboratories and a laboratory assistant."
>
> "Free board and lodging for single man. Free house and services for married man."
>
> "In certain circumstances assistance toward removal expenses of married teachers appointed from outside the geographical county may be provided, lodging allowance paid for periods up to six months, and there is a scheme whereby substantial loans can be made with a repayment period up to 30 years in approved cases."

Facing Professional Responsibilities

The science master may teach in any of several kinds of secondary schools —Public (Independent), Grammar, Secondary Modern, Technical, or Comprehensive. With additional preparation, he may teach in any of a variety of special secondary schools such as those for the physically handicapped or for the maladjusted.

The school year begins in September and continues until late in July. It is divided into three "terms" separated by vacations at Christmas and at Easter, each lasting about three weeks, and a summer vacation of six or seven weeks. Mid-term is usually marked by a long weekend of three or four days' duration.

Typically, the school day (from 9 a.m. to 4 p.m.) consists of four periods in the morning with a break of 10 or 15 minutes between the second and third periods. Then follows a lunch period of an hour and a half, after which there are four more periods with a break of 10 or 15 minutes between the sixth and seventh periods. Some schools have another variety of scheduling a function, that which, incidentally, is the responsibility of the Headmaster.

In Britain, a master in a secondary school teaches pupils ranging from age 11 to age 19. This is for pupils who enter the British secondary schools after having passed the known "11 plus" examination—so-called because it is taken during the year a boy or girl passes his eleventh birthday. The examination is designed to measure general aptitudes with attainment in arithmetic and English.

If he is employed in a Grammar School, a schoolmaster will be preparing his students for university entrance. In the early forms, his courses of study will be profoundly influenced by the GCE (General Certificate of Education) "ordinary level" examinations that his pupils will take for the first time at age 16. With upper-form classes, the master will be preparing his students for "advanced level" and scholarship examinations.

In the lower forms a science master will be teaching general science. But even before a student reaches his upper forms, if he shows promise, he will be directed into the study of physics, chemistry, or biology, any two of these, or even all three. It is noteworthy that although pupils are promoted through the forms by age, they nevertheless proceed in their studies at their own pace. Even on entering the secondary school, students are classified into two or three "streams" but not irrevocably. As they go on with their studies, students are promoted or demoted from stream to stream in accordance with their performance. Moreover, a student may be in a rapid stream for one subject—say mathematics—and in a slow stream for another—as French.

A science master teaching sixth-form classes teaches specialized science at an advanced level—equivalent to our college level. A student may remain in the sixth form for two or three years, that is to say up to the age of 18 or

Following the presidential address of The Lord Boyd-Orr at Bute Hall, SMA members and guests attended an enjoyable social where coffee and dessert were served.

19. He takes five subjects specializing in two or three, for example, mathematics, physics, and chemistry; or physics, chemistry, and biology; or mathematics, advanced mathematics, and physics. There are similar combinations for students specializing in the arts or in the humanities. About 60 per cent of all sixth-form students, at the present time, specialize in science.

In a secondary modern school, a science master may be assigned to teach classes preparing for the GCE "0" level examinations. But he is just as likely to be teaching general education courses or even vocationally oriented courses. He may even be assigned to teach classes of slow learners, most of whom will be leaving school at age 15. In a technical school a science master would be preparing pupils for GCE ordinary level examinations and also for advanced level examinations based on instruction in technology, whenever necessary.

In a large city, a science master may find himself teaching in a comprehensive secondary school with anywhere from 1000 to 2000 pupils, classified as to ability and directed into a variety of courses and streams.

In many schools the science master will enjoy the benefits of a laboratory assistant, and in some schools he will teach with superb facilities and equipment. However, he may become a "careers master" in others and be given the responsibility of advising pupils on suitable careers.

In the museum of the University of Glasgow, the statue of James Watt is viewed by A. Raskin of NSTA (left) and H. P. Ramage of SMA (right).

A master's salary is built upon a basic salary scale to which additions are made depending on additional education and responsibilities. The basic salary scale is 520 pounds ($1456) per annum rising by annual increments of 27 pounds ($77) to 1000 pounds ($2800) per year. To this scale is added, at minimum and at maximum, various amounts for approved full-time courses for a graduate degree, or for an honors degree. Additional allowances are granted for Head Teachers, Deputy Teachers, and Heads of Departments, the latter according to grades: Grade A, 150 pounds ($420); Grade B, 240 pounds ($672); Grade C, 330 pounds ($924); Grade D, 420 pounds ($1176).

There are differentials even within the grade of teacher, additional salary being paid to teachers undertaking special responsibilities, advanced work, etc. Other factors that may influence salaries are the size, nature, and location of a school. All this is described in detail in an official document known as the *Burnham Report*. It is of special interest to note that as of 1961-62 the salaries for men and for women will be the same at all levels.

A beginning teacher will receive, informally, much help and guidance from his Headmaster and from more experienced colleagues. But he is soon very much on his own in meeting his responsibilities in the classroom. It is taken for granted that he will grow in independence as he matures professionally. One of the masters with whom we spoke was horrified to hear that in some American schools, department heads visit classes and write reports which teachers are obliged to sign, and that these are placed in the teacher's file for permanent reference use.

Organization of the Curriculum

A basic objective of the English educational system is to provide for each student a program of study which is suited to his aptitude, his ability, and his maturity. To accomplish this objective, it is necessary, first, to assess the capabilities of students and second, to provide a variety of programs into which students may be directed on the basis of the assessment of their capabilities. Apparently the assessment of the capabilities of students in England is based somewhat less on formal testing and somewhat more on performance in classwork than in this country. Examinations based on subject matter, and set by agencies outside the individual school, play a prominent role in assessing the capabilities of students and in determining their future educational programs. At the secondary level, it has been the common pattern to provide separate schools to serve students of different capabilities. Thus, grammar schools are essentially preparatory schools for the universities. While there has been a movement toward comprehensive secondary schools, somewhat similar to many American high schools, it seems unlikely that the tradition of specialized secondary schools will change in England.

We are accustomed to think of a "course" as a horizontal "line" in the over-all curriculum. Thus we speak of "tenth-year biology" and "ninth-year general science." We say, "A student in our high school takes chemistry or physics in his eleventh or in his twelfth year." In general, we think of a course as being of a year's duration. At the end of the year, students take an examination, receive a cumulative mark, and breathe a sigh of relief. In the course of his year's work, the teacher seldom thinks of the student's past experience with the subject or of his future experience.

In the British system, the concept of a course is vertically oriented with respect to the curriculum. In other words, a course is considered to consist of two or three and up to six years of experience in a subject. It is interesting to note that we in the United States are just beginning to think in terms of a K-12 program in science education. To make any headway, we shall have to pry ourselves loose from our "horizontal" orientation.

Another noteworthy feature of the British program is the relationship between the teaching and evaluative functions. Through most of our high school years, the teaching and evaluative functions are combined in the teacher; the latter does the teaching and then judges its effects on the pupils. This situation tends to set up as the pupil's goal the mastery of the teacher rather than the subject. The implications in terms of variability in

objectives and standards become obvious under such a plan.

Only in the later years of high school, when our pupils face College Entrance Board Examinations, does an attitude develop comparable with that which is common in British schools. A pupil feels that the teacher is not against him, but with him to help jump over a formidable hurdle. In England, the definitive evaluation function is in the hands of experts. It is true that a system of national or regional examinations can be a strong force for conservatism, but it can also be a strong force for change, and in a democratic system, the examiners are not likely to be unresponsive to the best thinking and judgment of the organized teaching profession. Nor indeed would they be insensitive to enlightened public opinion.

It appears that English schools provide very good opportunities for those students with high capabilities in science. Traditionally, biology has been emphasized more in schools for girls, and chemistry and physics more in schools for boys, but serious efforts are being made to give these sciences equal status in all schools. The practice of rather intensive specialization at an early age may seem questionable to an American educator. It does not appear that there is much attention to the earth sciences in English schools except in the area of geography.

There is clear evidence that English schools make every effort to provide programs of study which are tailored to the needs of individual schools. For example, it is not unusual to find classes, at the upper levels of the secondary school, with fewer than ten students. Likewise the schedule for a school week is often quite complicated as a result of providing such a variety of special programs. Another indication of the concern for the individual student is the common practice of allowing students to spend an additional year in secondary schools in order to prepare for university scholarship examinations.

To conclude these impressions, it must be pointed out that the English educational system is a product of English history and culture and is designed to serve the present and future needs of the English people insofar as such needs can be discerned. Those aspects of science education in the English secondary school which impress an American educator might not be readily transferable to the schools of this country for they have evolved from a different background and are designed to serve a different culture.

A group of the SMA officers confer before opening of the annual business meeting.

Role of the Central Authority

Apparently, there is a common view in this country that education in England is strongly centralized, with the Ministry of Education exercising a large measure of control and direction. Quite to the contrary, as the local autonomy in educational matters is even more zealously practiced and guarded than in the United States. The responsibility for providing educational opportunities is in the hands of local educational authorities, whose members are elected. The local educational authority delegates to the heads of schools responsibility for the program of that school. Thus, there can be significant variations in the programs in comparable schools under the same local educational authority.

Within an English secondary school, the Headmaster customarily delegates much responsibility for devising the program of instruction in the several subject-matter areas to the teachers of that subject. Secondary schools have Heads of Departments who receive extra compensation and who have very real responsibilities for the instructional program in their subject-matter areas. Finally, the individual teacher within his own classroom has clear responsibility for such teaching that his students are well served. That a teacher shall be free to teach according to the dictates of his own conscience and judgment is one of the most cherished and zealously guarded prerogatives of the English schoolmaster or mistress. The principle and practice of local autonomy thus extends to the individual teacher.

These remarks should not be interpreted to mean that English education is without cohesiveness. There are strong and effective forces tending to bring about reasonable uniformity in the nature and quality of instructional programs throughout the country. For example, most science teachers are members of the Science Masters' Association (for men) and The Association of Women Science Teachers. These are mature professional organizations which, through national and regional meetings and through reports of committees, exert much influence on the content of courses and on the process of teaching. The prevalent custom of measuring the progress of students by means of examinations set by external authorities is another force tending to create uniformity in science instruction.

Undoubtedly, one of the most potent influences for uniform quality of education is the Inspectorate of the Minis-

try of Education. The Inspectorate is a body of about 500 experienced educators who provide liaison between the Ministry of Education and the schools. The majority of the inspectors are assigned to a region of the country. Within his region, the inspector is available to the schools for advice and consultation. Periodically schools receive a formal inspection in which a group of inspectors make a detailed examination of the school and its program. Following this, a report, often containing recommendations for change, is submitted. The school is under no compulsion to adopt the recommendations. Since the inspectors are members of the same agency, they reflect a uniform point of view on educational matters which must have a large effect, in the long run, on the nature and quality of education in the schools.

It is an important function of inspectors to provide the Minister of Education with information concerning the schools. Thus, it appears that the national government is well supplied with exact and current information as a basis for establishing national policies and enacting legislation affecting education at all levels.

Participants attending the International Conference at the Ministry of Education in London included (seated l. to r.): R. A. R. Tricker, Chief Science Inspector; J. G. M. Allcock, Chief Inspector of External Relations; J. O. Roach, Head of Overseas and General Division. Standing (l. to r.) are Keirstead, Schlessinger, Raskin, Subarsky, and R. K. Kichlu of India.

Science Teaching Facilities

Since World War II the British have built many new secondary schools. Many of the older schools have been remodeled and at some of these, new science buildings have been constructed. Facilities for science teaching have received much attention in the last several years.

Even assuming that all the schools we visited were better than average, we were impressed by the physical space allotted for science instruction and by the equipment available for demonstrations by teachers and for experimentation by pupils. Science facilities in new schools appear adequate. This condition is related apparently to the rather close control of new construction exercised by the Ministry of Education. Instruction in science includes laboratory work by students. As much as a third of the time even in early years of the secondary school may be devoted to laboratory work. Equipment and supplies for this purpose seemed adequate in variety and in quantity. It should be emphasized that this condition may be due, in part, to the fact that science courses in the upper years of an English secondary school are equivalent to those often found in the first, or even the second, year in an American college. It would appear, however, that the nature and quality of science instruction in English schools are not usually limited by the unavailability of equipment and supplies.

In those schools that had been constructed within the last four to six years we found a definite type of teaching facility. The comprehensive schools usually had combination classroom laboratories similar in structure and furnishings to those found in the United States. In the schools visited, whether they were grammar schools with long histories of tradition or the more recently built comprehensive or technical high schools, we found the classrooms to be large for the number of pupils. Stockrooms were much larger than the usual stockrooms in the United States. Large preparation rooms were connected to one or two laboratories. Photographic darkrooms and optics rooms were available for student use. There were separate balance rooms in some of the schools, and well-equipped workshops for the construction of apparatus were found.

In the classroom laboratories used by the lower forms in secondary education, the usual size allowed from 32 to 44 square feet per student. In the sixth-form laboratories, 64 square feet per student was the usual space allotment. In most of the schools a great deal of window space was provided, sometimes on both sides of the room. In spite of this large amount of window space, most of the laboratories and classrooms had dark curtains for completely darkening the room for projection purposes. The furniture in the laboratories was usually custom built, finished in highly polished natural wood. In all the newer schools the furniture was in excellent condition, even after several years of hard usage.

In some of the classrooms the amount of storage space was so large that one got the impression there was much more storage space available than there was equipment to put into it. All of the laboratories were provided with gas, running water, and electrical outlets, both AC and low-voltage DC.

In most of the laboratories wooden stools were provided which matched the highly polished furniture. With the exception of some chemistry laboratories, most of the plumbing facilities were found along the sides of the room. The demonstration desks had hot and

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cold water as well as gas outlets and electrical outlets. Chalk boards and tack boards were limited in total area. An interesting innovation of the chalk board was the endless belt roller made of heavy cloth printed black or green and backed by a solid surface. This facility was used extensively both in the secondary schools and in colleges which we visited.

In most of the laboratories there was considerable shelf or cupboard space provided around the room. Usually these cupboards matched the tables and desks. We found these to be very neat and orderly, probably the result of having full-time technicians or laboratory assistants working in the science facilities.

Artificial lighting of the rooms in some cases seemed inadequate. One school we visited in Scotland had fluorescent lights. We were informed by the inspectors that many of the newer schools in England do have this type of lighting, too. Greenhouses were found in three of the six schools visited, but in only one school did we find an animal room for class use.

Perhaps the most conspicuous pieces of equipment found in the laboratories were large numbers of analytical balances. These were often found on the side shelves in the laboratories. In one school they were kept in a special balance room. We were told these balances were used by boys and girls from age eleven on. In some of the schools visited we found provision for one such balance for each two students in the classroom.

In the laboratory block of the High Wycombe Royal Grammar School the facilities were so arranged that interchangeable drawers of three different depths could be fitted in storage cupboards, demonstration desks, and classroom tables. These were custom built and would fit anywhere within the facilities of eleven different laboratories. The provision of space and materials within the laboratories gave the impression that the intention of the British science masters was to make laboratory work the heart of science teaching. This impression was reaffirmed in our talks with members of the Ministry of Education. We were quite aware that many of the schools which we were not privileged to visit are working under the same handicaps that we have here in the United States.

A general purpose of our mission was to attend the sixtieth annual meeting of The Science Masters' Association (SMA) at the University of Glasgow. A specific purpose was to learn more about SMA, to observe SMA in action and, without prejudice, to make some comparisons with NSTA.

SMA in Action

The SMA is about the same age as NSTA, if we consider NSTA's origin to be the NEA Department of Science Instruction (established in 1895). In terms of membership, SMA enrolls about 6000 science masters and college or university professors, a gain, they proudly announced, of nearly 1800 in the past year. If based on the total number of science masters in Great Britain, their percentage of membership is about twice that of American secondary science teachers in NSTA. There is a separate Association of Women Science Teachers and the merger of the two groups, which seems to be coming, might push the percentage even higher.

During the past year, SMA completed plans to establish and staff a headquarters. The Association took an eleven-year lease on a large, three-story house with a beautiful yard and small greenhouse at 52 Bateman Street in Cambridge, and spent some $6000 in renovating, decorating, and partially equipping it for SMA purposes. Warden of SMA House is Mr. H. P. Ramage, a Cambridge graduate and retired science master. He is assisted by an employed secretary-librarian. Mr. and Mrs. Ramage occupy one floor of the house. Thus far, the headquarters have been set up as administrative offices with a library which could become a reference research center. NSTA has contributed to the center a complete set of all of our publications and will send copies of future publications. Issues of *The Science Teacher* and the *Elementary School Science Bulletin* go regularly to the center.

The schedule of SMA sessions comprising the meeting at Glasgow was not greatly different from that of an NSTA convention—except that the schedule was much less crowded and the pace much more leisurely. A major portion of the time was given over to lectures by scientists and other specialists, two or three usually being presented in parallel. Among the lectures offered at Glasgow were the following: "The Detection and Measurement of Elementary Particles and Quanta"; "The Boundaries of Science"; "The Chemical Basis of Heredity"; "The Human Sciences in a Scientific World"; "Educational Problems in USA and USSR"; and "Association Between Invertebrates and Unicellular Algae." Usually there was not time for discussion following the lectures, but in the corridors afterward could be heard the standard variety of comments: "An excellent presentation"; "I didn't follow all of it"; "Why don't they talk at a level we can use with our students?" and so on. One lecture, given in two installments, was especially well attended and produced much lively discussion; namely, "The Physical Science Study Committee Program of the USA" by Francis L. Friedman of Massachusetts Institute of Technology. He also had on display a full working array of the PSSC laboratory equipment.

The SMA meeting included film showings, exhibits by about 90 publishers and purveyors of equipment, and a special exhibition on "Atomic and Molecular Structure and Nuclear Energy" in which ten companies or agencies, including the United Kingdom Atomic Energy Authority, participated. A feature of the annual meeting of SMA is the members' exhibit of new teaching devices and demonstrations. Some thirty of these intriguing inventions—ranging from gadgets to high-precision arrangements—were on continuous display in a large laboratory with the originators there at stated hours to demonstrate and discuss. The nature of most of these devices was closely akin to many of our "Here's How I Do It" presentations. The kind of session common to our meetings but completely absent at SMA is the discussion-type session in which panels or small groups of participants exchange and share. Many of the science masters we talked with expressed a strong desire for opportunities of this kind.

The only meal function in the SMA schedule was a modest but extremely pleasant Association dinner held in a dormitory dining room. Only a few officers of SMA comprised the head table, and there were no guests to introduce, no "greetings," no speeches. The chairman made a few remarks and did announce the names and affiliations of the fifteen or so of us from other

countries who were attending the meeting. The excellent roast beef was accompanied by a choice of wines. Prior to the dinner, we were privileged to attend a get-together of the officers and guests of SMA for a "wee sherry." Here we were introduced to the Honorable Lord Boyd-Orr, Chancellor of the University and President of SMA. An eminent scientist, he is a former head of the Food and Agriculture Organization and a Nobel Peace Prize winner.

After the Association dinner, everyone reported to historic Bute Hall to hear Lord Boyd-Orr's presidential address, "Education for the Atomic Age." It was on this occasion that a departure from custom was made. The chairman again introduced and welcomed the visiting guests of SMA and then called on Robert H. Carleton (NSTA) to respond on behalf of all the foreign science teachers. After brief remarks, Mr. Carleton presented Lord Boyd-Orr with a mounted certificate of Honorary Life Membership in NSTA. This gesture proved to be more appropriate to the occasion than was anticipated because, as we shall see, the President of SMA really occupies an honorary position. In a sincere response, Lord Boyd-Orr said, "I accept this with personal pride and as symbolic of the strong ties between our Associations and of the important tasks ahead in international education which we must share to our fullest capacities in every possible manner."

An offering of tours and visits to laboratories rounded out the program with one exception, the Annual Business Meeting. Three of our delegation went on the field trip to the Marine Biological Station at Millport on the quaint, secluded Isle of Cumbrae. The day for this dawned beautifully clear and sunny, a welcome change after a week of dreary, miserable fog, rain, and snow. The journey to Millport consisted of an hour's train ride and a forty-minute ferry boat trip, the course of which took us close by the location of the new U.S. Polaris submarine base. Meanwhile, the other two NSTA delegates, as well as some of the other foreign visitors, visited a couple of schools and then attended a special reception in the Glasgow City Hall where they were officially received by the Lord Mayor.

The annual Business Meeting of SMA is conducted somewhat in the manner of the annual meeting of the NSTA Board of Directors, except that all business was transacted in an hour and a half. The meeting was open and all SMA members were entitled to be present and vote. About 150 members attended the session. Here policy questions were decided and actions taken which became binding upon the Association. Several of the issues were of the kind that would be referred to the entire membership of NSTA for a vote by mail ballot. One action taken doubled the annual dues of SMA, raising the amount from one pound to two pounds (about $6). Interestingly, a companion action now empowers the SMA Committee (comparable to our Board of Directors) to offer reduced fees to science teachers in other countries, the amount of dues for each country to be decided by the Committee. This action was closely related to another proposal, namely to increase SMA activities on an international scale. Dr. Henry F. Boulind, a science lecturer in the Department of Education at the University of Cambridge, is acting as Secretary for this work.

The governing body of SMA, the counterpart of the NSTA Board of Directors, is an elected Committee comprised of the Chairman (comparable to our President), four Secretaries, a Treasurer, an Editor, a Librarian, two Trustees, and ten Other Members some of whom represent defined districts (comparable to our regions). The SMA equivalent of our Executive Committee would be made up of the Chairman, the four Secretaries, and the Treasurer. Since it is the custom of SMA to hold its annual meeting at a college or a university, the official head of that institution, if willing, is elected President of SMA for the year ending with the meeting. Thus the 1961-62 President, elected at Glasgow, is Sir Patrick Linstead, Rector of the Imperial College, London, where the 1962 meeting will be held.

Much of the work of SMA is carried on by committees such as the Science and Education Committee, with its several Panels, or the Secondary Modern Schools Committee. Whereas NSTA has thirty-five or more committees on the book this year, the program of SMA is handled by about ten committees. Each committee prepares a careful annual report and these are published in the official journal, *School Science Review* (strongly recommended to all U.S. science teachers). At Glasgow, galley copies of these reports were available so that interested members could read them prior to the Business Meeting. When the reports were introduced, a few questions were asked and answers given, then the motion to accept was made, seconded, and voted —all in a matter of not more than ten minutes. Similarly, the election of a new Chairman of the Committee, the re-election of the Secretaries and the Treasurer, and the filling of vacancies among Other Members on the Committee were accomplished in less than twenty minutes. The Committee itself (rather than a special Elections Committee as in NSTA) proposed candidates and there were a few nominations from the floor, some of the latter being elected rather than the Committee's candidates.

A gratifying agenda item was a pleasant short speech by the Chairman, Mr. E. W. Moore, recognizing the American delegation, expressing appreciation to NSTA and NSF for making our visit possible, and voicing the hope that more NSTA delegates will attend future SMA meetings. The resounding "Hear, hear's," stamping of feet, and pounding of fists on tables made one believe that the members fully approved.

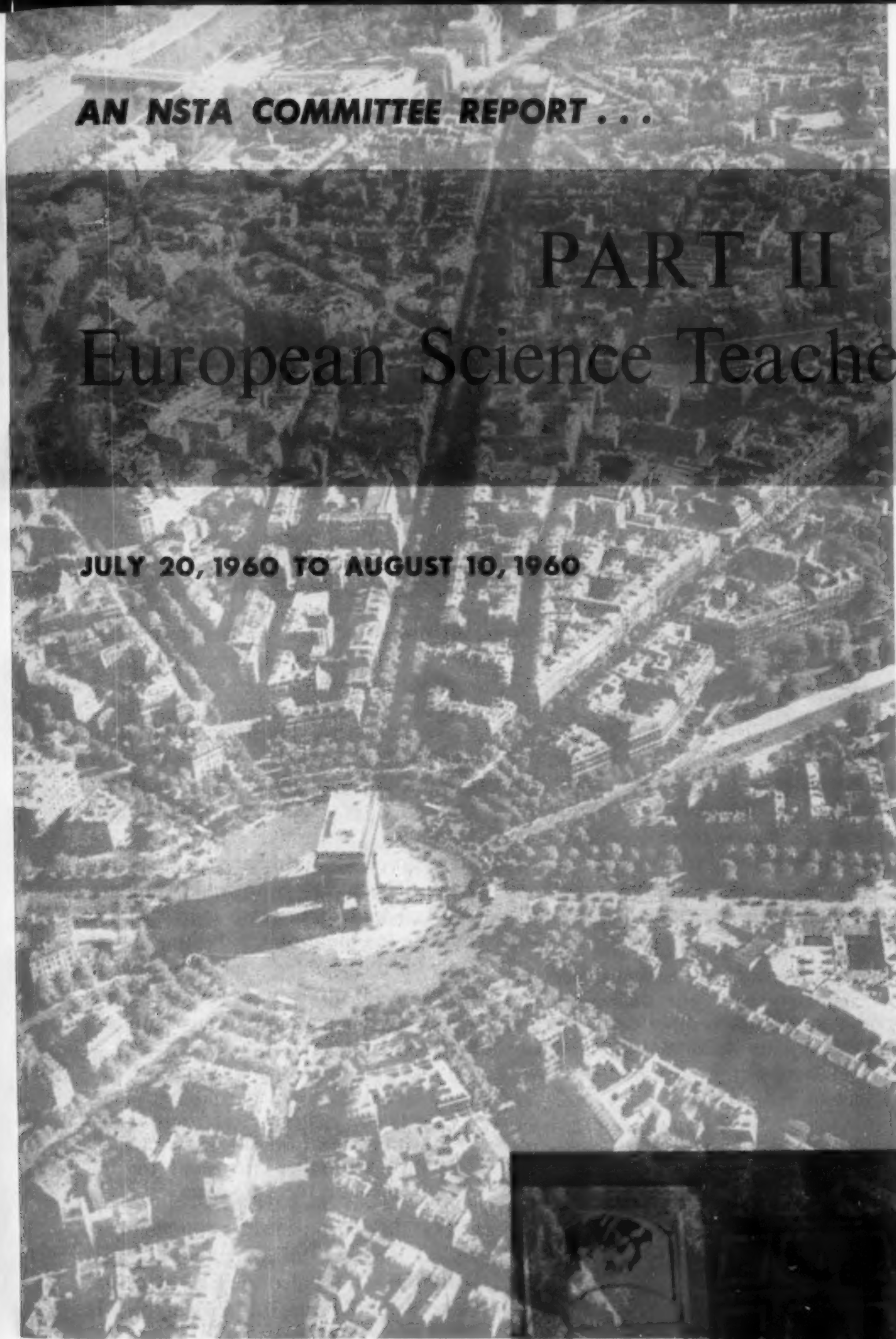
Appreciations

The members of this first official NSTA international delegation hope that these efforts have been satisfactory and will prove fruitful. We deeply appreciate the honor and privilege of representing the Association. It seems more than notable that the entire project was conceived, approved, planned, financed, and launched in a span of about three weeks. Obviously, the assistance of many others made this possible, as well as a successful execution of the project. We extend particular deep appreciation and thanks to the officers of SMA; the NSTA Executive Committee; the National Science Foundation; Mr. Robert Morris of the British Embassy in Washington, D.C.; Dr. R. A. R. Tricker, Chief Science Inspector of the British Ministry of Education; and Mr. H. M. Lockett, annual meeting Secretary of SMA, whose sudden, untimely death within a week after our departure from London saddened our return.

AN NSTA COMMITTEE REPORT . . .

PART II
European Science Teacher Study Tour

JULY 20, 1960 TO AUGUST 10, 1960



UNTIL very recently, the activities of our Association have been confined entirely to the continental limits of the United States. While it is true that our headquarters in Washington is visited frequently by teachers of science and administrators from abroad, that we do have members in about forty-five countries, that our professional journal occasionally carries an article by an overseas member, and that one of the guest speakers at our last annual meeting was a British scientist, it is also true that our interest and participation in international activities as an Association has been passive and unenthusiastic compared to what other societies are doing.

This situation was changed abruptly in the summer of 1959 when Donald Decker, then President of NSTA, and

The tour group enjoys afternoon tea at Dulwich College in London.

The Prime Meridian at Greenwich captivates the interest of Madeline Kearns, as she lines up her view for a camera shot.

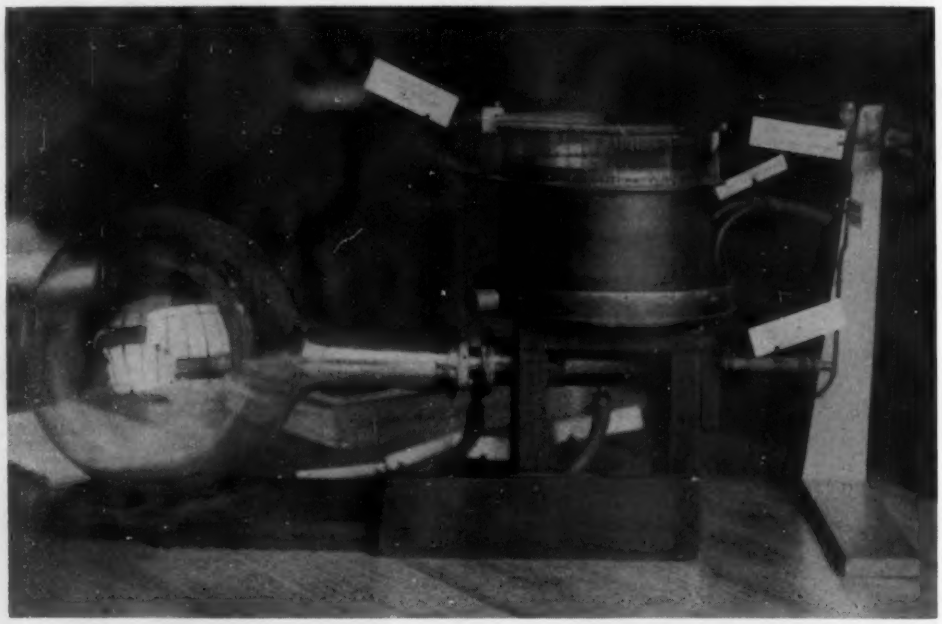
W. H. Dowdeswell, head of the science department at Winchester College, begins a discussion with NSTA members of the tour.

Robert Carleton, the Executive Secretary, conceived the idea of sponsoring a summer science tour for our members. Dr. A. Raskin describes this tour and some of the adventures of our Association in the field of international activities.

The discussions and planning of Decker and Carleton became a reality on July 19, 1960, when the members forming NSTA's 1960 European Science Teacher Study Tour boarded a BOAC jet at Idlewild Airport, New York City. The group consisted of secondary school teachers of general science, biology, chemistry, and physics; college teachers of science; two elementary school supervisors; a research chemist; and two other teachers making a total of 34.

The major purposes of the study tour were:

1. To establish and strengthen, through conferences and seminars, personal contacts with our colleagues and counterparts in other countries, and to explain some of our problems to them.



The original Cloud Chamber of C. T. R. Wilson was viewed at Cavendish Laboratory, Cambridge University, England.

To this end, the tour participants met with groups of science teachers and other members of the educational fraternity in Edinburgh, Winchester, London, Cambridge, Oxford, Amsterdam, Bonn, Munich, Geneva, and Paris. The meetings in total were productive, and there were ample opportunities for the group to become familiar with the problems faced by science teachers in other countries, and occasionally to acquaint them with our methods of operation.

2. To visit primary and secondary schools, colleges, and universities with a view toward a study of facilities and other provisions for implementing the curiculum.

For this purpose, the tour members visited schools in Winchester, West Dulwich (near London), Munich, Geneva, and Paris, and universities in Cambridge, Oxford, and Edinburgh. Several of the schools we visited were extremely well-equipped and supplied with apparatus which would give them equal or superior rank with the best American secondary schools.

3. To visit and study places of special current and historical interest to teachers of science.

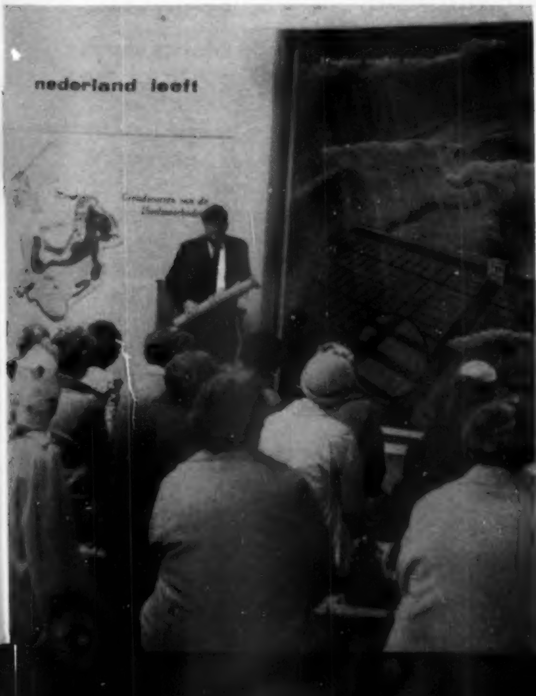
The group visited the Agricultural Research Council's Poultry Research Centre at Edinburgh, the radiotelescope at Jodrell Bank, the archaeological ruins of Stonehenge at Salisbury, the National Institute for Research in

Nuclear Science of the Rutherford High Energy Laboratory and the Medical Research Council Unit at Harwell, the Science Museum in South Kensington in London, the National Maritime Museum at Greenwich, the History of Science Museum at Cambridge, the Floriade in Rotterdam, the Delta Plan and the Zuider Zee Reclamation Project in Holland, the Deutsches Museum in Munich, the Rhone Glacier and Mount Pilatus in Switzerland, the headquarters of the World Health Organization at Geneva, CERN (Center for European Nuclear Research) at Geneva, the Natural Sciences Department of UNESCO in Paris, the Pasteur Institute in Paris, and the Joliot-Curie Nuclear Energy Laboratories at the Centre d'Orsay near the city of Paris.

In addition, the group visited with several Americans who were teaching in Munich and Heidelberg; we had meetings with Dr. Ludwig Audreith, Scientific Attache of the American Embassy at Bonn, and with Mr. Vaughan DeLong, Consul General at Edinburgh. Members of the group attended performances of *The Merchant of Venice* at Stratford-on-Avon and *Der Rosenkavalier* at Salzburg. Many members of the group took advantage of their free time to visit local universities, museums, and other places of cultural interest. A formal part of the group's activity consisted of making coach orientation tours of many of the cities we visited. This was done in Edinburgh, Stratford-on-Avon, London, Rotterdam, Amsterdam, Heidelberg, Munich, Berne, Geneva, and Paris. Other activities of the group included a Rhine River excursion and a visit to Rothenburg, a medieval walled city in Germany.

The group visits a physics laboratory located at the *Luitpold Oberrealschule* in Munich, Germany.

The visit to the Zuider Zee polders begins with a briefing session. The land reclamation project in Holland of dikes and pumping stations serves to protect that area from the devastating storms of the North Sea.



We presented bronze medallions with the official NSTA insignia to about twenty persons who had served as our hosts or guides, or in other special capacities along the way.

A comprehensive 96-page report (mimeographed) of the 1960 European Study Tour has just been issued by our Association and is available for interested readers. (See April *TST* page 57.)

The project would never have been completed without the full participation of the 32 individuals who had been willing to "sign up" for the tour. (The Assistant Director and Director of the tour included). They not only signed, they paid every penny of the cost themselves—there were no government subsidies, reduced fares, or other forms of financial support. Now it is true that those who paid had the fun; they visited six countries and had the wonderful times that go wth "enduring the vicissitudes of travel with humor and good grace." But on the other hand, these 32 teacher tourists devoted nearly half of their non-traveling days to professional conferences, school visits, and other specially planned science teaching-related activities. Moreover, they have prepared accounts of their visits, conferences, and other experiences, all of which are published as indicated above. For their participation and contributions, we are deeply indebted to all members of the 1960 Science Study Tour. Dr. Abe Raskin, Director of the Tour also prepared this summary and submits an outline of the daily tour schedule.

Visits to Places of Scientific Interest

July 21	Poultry Research Centre, Agricultural Research Council, Edinburgh, Scotland
July 22	Radiotelescope, Jodrell Bank Experimental Station, Lower Withington, Cheshire, England
July 25	Stonehenge, Amesbury, England
July 27	National Institute for Research in Nuclear Science, Harwell, England
July 27	Medical Research Council Unit, Harwell, England
July 28	Science Museum, South Kensington, London, England
July 29	National Maritime Museum, Greenwich, England
July 31	Floriade, Rotterdam, The Netherlands
Aug. 1	Delta Plan, The Netherlands

Special coach orientation tours were arranged for the NSTA group.

Aug. 3 Zuider Zee Reclamation Project, The Netherlands
Aug. 12 Deutsches Museum, Munich, Germany
Aug. 16 Rhone Glacier, Belvedere, Switzerland
Aug. 16 Mount Pilatus, Lucerne, Switzerland
Aug. 18 World Health Organization, Geneva, Switzerland
Aug. 19 CENR (Center for European Nuclear Research), Meyrin, Switzerland
Aug. 23 Pasteur Institute, Paris, France
Aug. 25 Joliot-Curie Laboratories, Centre d'Orsay, France

Visits to Schools, Colleges, and Universities

July 25 Science School, Winchester College, Winchester, England
July 26 Kingsdale School, Alleyn Park, West Dulwich, London, England
July 26 Dulwich College, West Dulwich, London, England
July 27 University of Oxford
July 30 University of Cambridge
Aug. 11 Luitpold Oberrealschule, Munich, Germany
Aug. 11 Ludwig Oberrealschule and Gymnasium, Munich, Germany
Aug. 19 College de Geneve, Geneva, Switzerland

NOTE: The photographs of Edinburgh on page 10 and the one of Paris on page 21 were reprinted by permission of the NEA Travel Service Division.

Conferences and Seminars

July 21 Scottish principal science teachers and headmaster, Edinburgh, Scotland
July 26 Ministry of Education, London, England
Aug. 3 Netherlands science educators, Amsterdam, The Netherlands
Aug. 5 Permanent Conference of the Ministers of Culture, Bonn, Germany
Aug. 11 State Ministry for Education and Culture, Munich, Germany
Aug. 19 Swiss teachers of science, Geneva, Switzerland
Aug. 23 UNESCO, Paris, France
Aug. 25 Institut Pedagogique National, Paris, France

Other Activities

July 19 Visit to the garden outside of Prestwick Airport
July 20 Visit to the home of Consul General DeLong at Edinburgh, Scotland
Aug. 6 Visit with the Science Attache, Dr. Ludwig Audrieth, at Bonn, Germany
Aug. 7 Rhine River excursion
Aug. 9 Visit to Rothenburg, Germany

A-OKAY
Tribute to Freedom 7, Alan B. Shepard, Jr.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Commander Alan B. Shepard describes the operation of the pressure suit worn during his flight.

THE National Science Teachers Association pays tribute to a scientific achievement of our era made possible through Project Mercury of the United States National Aeronautics and Space Administration.

Especially do we honor Commander Alan B. Shepard, Jr., of the United States Navy, and each of his astronaut colleagues.

As we witnessed the ceremony of the warm and joyous welcome accorded Commander Shepard and his fellow pilots by citizens in the nation's capital on Monday, May 8, it was unanimously agreed that a tribute to this epoch of scientific achievement should be recorded in our professional journal. With the last form of this issue of *TST* yet to be placed on the press, the photographer was sent to the White House grounds to obtain photographs of Commander Shepard's visit.

Science teachers may rightfully claim a share of credit in pushing forward the frontiers of knowledge. Most of the new knowledge about space has been secured through the development and use of techniques and instruments which perhaps were considered "wild ideas" less than a decade ago. But the improvement of devices and research procedures grows out of man's basic knowledge, his ingenuity and courage, and his *curiosity* to probe fearlessly intc the unknown, knowing full well that the more he probes, the more endless the frontier becomes.

Freedom to learn, to choose, and to act is an essential part of our heritage, and could not have been more ably demonstrated than by the recorded event of America's man-flight into space launched at Cape Canaveral on Friday, May 5, 1961.

With this evidence so strongly in view, we may well ponder the questions—How did this successful project begin? Where did the scientists, engineers, and technicians come from who made it possible?

Talk to a three-year-old child and you will soon discover within that individual a natural *curiosity,* an innate quality of the human mind. This curiosity in the field of science must be nurtured in the early years, even before the child enters school, if maximum potential is to be realized.

In this educational endeavor, the science teachers at all levels have a responsibility, not only to guide and encourage students in their choice of careers, but to demonstrate the intellectual challenge and the excitement of science in supporting our technological culture in the framework of a free society.

With the accelerated pace of technological developments, we cannot foresee the new frontiers which will be revealed tomorrow. But the role of the science teacher is clearly defined, and the record achievement of the "A-OKAY" astronaut might be shared by every classroom teacher who has had a part in developing a scientist, engineer, technician, or able student. It is "A-OKAY" to the efforts of the many dedicated and selfless teachers who are an integral part of the team in promoting the science progress of our nation.

Commander Alan B. Shepard, Jr. was born November 18, 1923 in East Derry, New Hampshire. He attended primary school in East Derry and was graduated from Pinkerton School, Derry, in 1940. He studied at the Admiral Farragut Academy in New Jersey before entering the United States Naval Academy. In 1944, he graduated from Annapolis and in 1958 graduated from the Naval War College, Newport, Rhode Island. During World War II, the astronaut served on the destroyer Cosgrove in the Pacific. Later he entered flight training at Corpus Christi and Pensacola. Since receiving his wings in March 1947, he has taken part in numerous high-altitude tests and related flight experiments for the Navy. Prior to his selection as an astronaut for Project Mercury, he had 3600 hours of flying time with 1700 hours in jets.

Astronaut Shepard is acclaimed by 250,000 admirers as he rides to the United States Capitol to be received by Congress prior to the nationwide televised press interview relating to his flight. (Commander Shepard, waving to the crowd, is seated with his wife and Vice President Lyndon Johnson.)

WILLIAM E. MARKEY, PHOTOGRAPHER

Culture Media for Protozoa and Algae

The selection presented has been taken from one of a series of Culture Leaflets prepared by Ward's Natural Science Establishment, Inc. The methods for preparing controlled cultures are many and varied.

IN order to facilitate the study of living organisms in the laboratory, Culture Leaflet No. 5 was prepared to describe a series of culture solution concentrations that may be used immediately with the addition of the required amount of distilled water.

Dv 7—Amoeba Medium: For the culture of Amoeba and other Sarcodina. The medium as shipped consists of a concentrated salt solution that is highly recommended for the culture of various Sarcodina. This solution is to be diluted with the required amount of distilled water to make the number of milliliters required. After dilution, it is ready for immediate use. Depending upon the species to be cultured, either polished rice or boiled wheat grains should be added to the solution and the medium inoculated with the food organism *(Chilomonas, Colpoda,* or perhaps *Paramecium)* and finally the organism to be cultured.

For containers it is recommended that small 4½-inch diameter finger bowls be used. These should be stacked and the top bowl covered to avoid gross contaminants from the atmosphere. The rice or wheat grains should be added at the rate of four grains for each 200 ml of medium.

Dv 7.1—Paramecium Medium: For the culture of *P. multimicronucleatum, P. caudatum, P. aurelia,* and other ciliates. This set consists of a bottle of liquid medium that may be added to the required amount of distilled water to make the number of milliliters required. A small vial of boiled wheat grains and a small bottle of boiled timothy hay is included. These latter two portions may be held for some time under refrigeration without harm.

The medium may be placed in finger bowls, flasks, battery jars, or any suitable container. The addition of either wheat grains or timothy hay at intervals will prolong the life of the culture. For a determination of the amount of wheat or hay to add for the species under culture, reference may be made to Culture Leaflet No. 1[1].

Dv 7.2—Paramecium bursaria Medium: Add the contents of the small bottle to 250 ml of distilled water in a 500-ml culture or Erlenmeyer flask. The medium is then ready for use, and the *Paramecium bursaria* may be added. Place the flask in diffuse light.

If it is desired to culture conjugating strains, use twice as much medium and mix in two flasks. Avoid contamination of the two strains by using separate pipettes for the examination of each.

Dv 7.3—Volvox Medium: For the culture of *Volvox* and related forms. This set consists of four numbered solutions 1, 2, 3, and 4 and one small vial. For 1000 ml of solution, take 900 ml of distilled water and add the solutions in order, mixing thoroughly after each addition. After the solution has been mixed, add the contents of the vial. A slight precipitate may appear in the solution. This precipitate does no harm to the algae and merely represents a slight excess of salt content.

Place cultures in a cool place with adequate illumination. A north window or fluorescent light fixture that can be placed from 6 to 18 inches away from the culture will suffice. For containers, finger bowls, battery jars, or any satisfactory, sterile vessels are recommended. Keep the culture covered or plugged to avoid contamination.

For 5000 ml of solution, take 4000 ml of distilled water and proceed.

Dv 2100—Basic Culture Solution: For the culture of many fresh-water algae. This set consists of 8 vials of nutrient solution consecutively numbered, one through eight. For one liter of solution, take 940 ml of distilled water, and for 5 liters of solution, take 4700 ml of distilled water. In either case, add in order the contents of the vials, numbered one through six, mixing well after each addition. Then add the contents of Vial No. 7 and Vial No. 8 in that order. Mix well, and the solution is ready for use. (Refer to Culture Leaflet No. 14.)

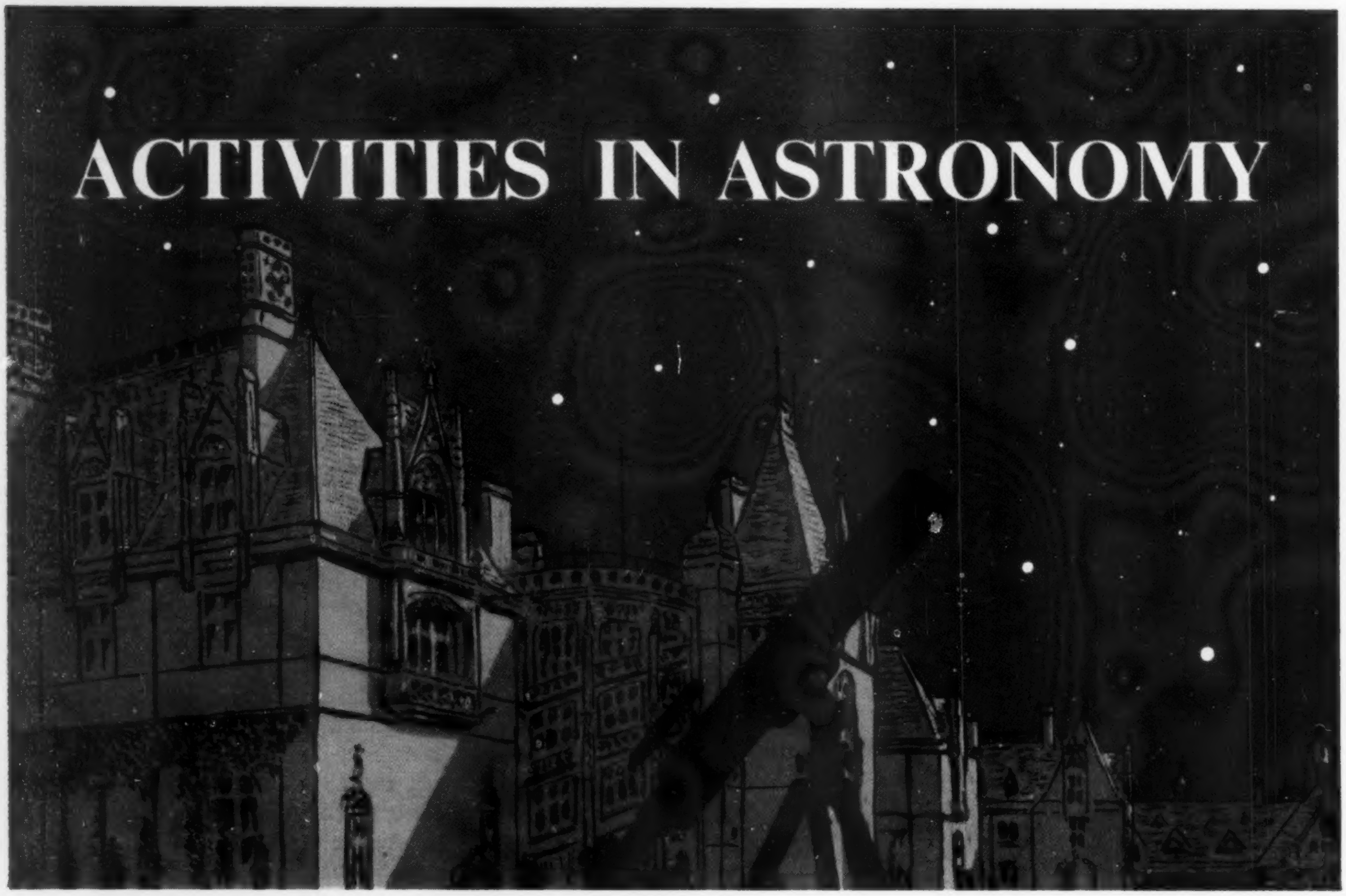
Series of Culture Leaflets

To date, Culture Leaflets Numbers 1 through 10, and Number 14 have been issued. As soon as Numbers 11, 12, and 13 are available, these will be distributed. A limited quantity is free to science teachers from Ward's Natural Science Establishment, Inc., P.O. Box 1712, Rochester, New York.

1. Culture of Protozoa in the Classroom.
2. Observations on the Feeding Reaction of Living Protozoa.
3. Use of Protozoa in Investigations of Cellular Structure.
4. Study of Living Protozoa by Use of Vital Stains.
6. Immobilization of the Living Protozoa.
7. Rearing Hydra in the Laboratory.
8. Culture of Planaria and other Worms.
9. Preparation of Media for Drosophila and Use of Mold Inhibitor.
10. Methods for the Culture of Artemia.
14. Culture of Algae in the Laboratory.

[1]For a determination of the amount of wheat or hay to add for the species under Dv 7.1, see Culture Leaflet No. 1, *Culture of Protozoa in the Classroom.* For more specific methods for the culture of algae (Dv 2100), refer to Culture Leaflet No. 14, *Culture of Algae in the Laboratory.*

ACTIVITIES IN ASTRONOMY



By ARTHUR G. SUHR

Science Teacher, Jefferson High School, Jefferson, Wisconsin

This report was ar entry in the 1960 STAR (Science Teacher Achievement Recognition) awards program conducted by NSTA and sponsored by the National Cancer Institute, U. S. Public Health Service.

THE study of astronomy in the average high school is given little emphasis. In this report the author suggests improvement in its presentation by supplementing the material included in the usual high school texts and workbooks with special activities. The demonstrations performed in this astronomy unit can be adapted to meet teaching situations in the general science program and can be used also in other subject areas.

Telescope and Solar Studies

Construction of a telescope was the largest project undertaken. With the assistance of one of the students, construction began of a four-inch reflecting telescope. The component parts were mounted on a board so that the telescope construction and operation could be demonstrated in the classroom and set up for observation as well.[1] The assembly was completed in about six hours during class and in a few evening sessions working together.

Considerable time was spent in discussing the sun. This afforded an opportunity for several worthwhile experiments and demonstrations. For instance, the class may observe the sun for sunspots by projecting its image on a white poster board or screen with a pair of binoculars or a telescope. Many variations of this experiment are possible. The method used in this class was to clamp binoculars on a rod mounted on a standard tripod. The image is best viewed when cast on a shadowed area of the screen. If this project is repeated for several days in succession, the relative positions and size of the spots can be observed each day. Where the spots are large and long-lived, it is possible to show that the sun turns on its axis.

The phenomenon known as the "Northern Lights" or *Aurora Borealis* serves as one example to introduce the study of the sun's radiations. The *Aurora* is formed in part from electrified particles emitted from the sun causing the rarefied atmosphere above the poles to glow. In a class demonstration, this phenomenon may be simulated with a vacuum discharge tube, a piece of apparatus available in many physics laboratories.[2] The influence of the earth's magnetic field on this glow was demonstrated by passing a horseshoe magnet over the vacuum tube and observing the deflection of the

[1] Parts for telescopes may be secured from many sources such as the Edmund Scientific Company, Barrington, New Jersey.

[2] C. L. Stong. "The Amateur Scientist." *Scientific American*, 194:132. February 1956; *loc. cit.*, 198:112. February 1958. National Academy of Sciences-National Research Council. *Planet Earth—Classroom Experiments.* Washington, D. C. 1958.

purple glow. These demonstrations are described in most physics textbooks.

The ultraviolet portion of the electromagnetic spectrum may be introduced at this time. This was demonstrated with fluorescence by using a General Electric Purple-X bulb as the ultraviolet source.[3] Materials were obtained from advertising firms that use fluorescent inks for printing. The items were mounted on poster board and displayed in class.

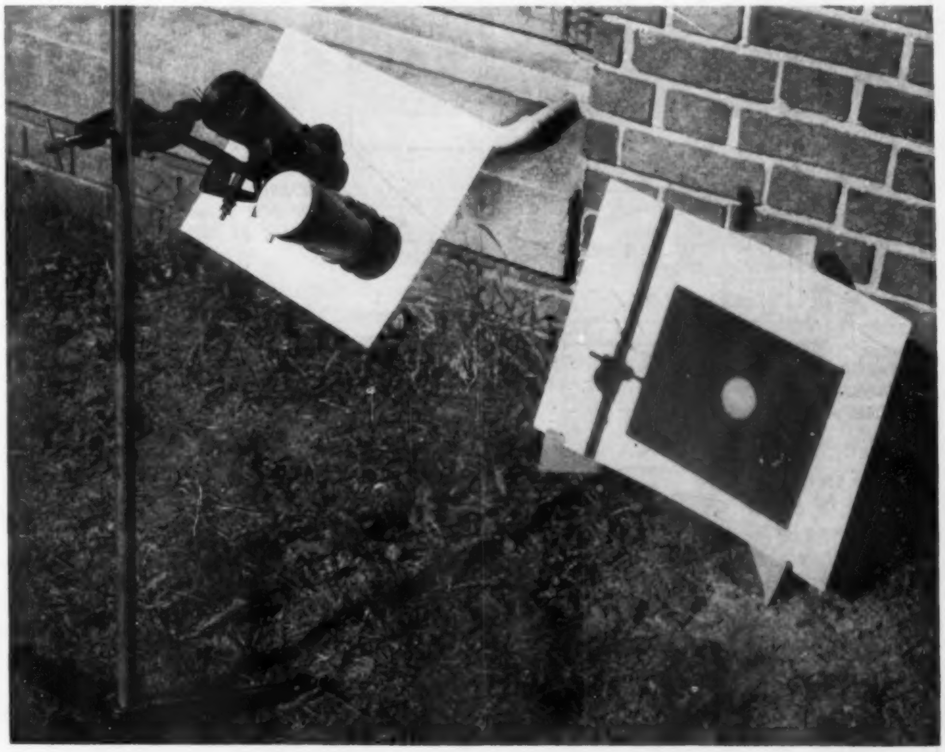
Pendulum Project

A unique device for demonstrating the rotation of the earth on its axis is the Foucault pendulum [4] which can be produced from an old shot-put. Suspension of the pendulum, the most important part of its performance, was accomplished by imbedding a hook in the metal shot, attaching it to piano wire, and allowing the assembly to hang from a bracket on the wall. The supporting wire was clamped between two pieces of angle iron welded to the underside of the bracket. (See Figure 1.) To insure accuracy, the pendulum must be completely motionless before the experiment begins. The bob was tied to one side of its natural arc by a string the night before the demonstration. At class time the next day, the pendulum was started in motion by burning the string, As the assembly began to swing, a large piece of poster board is placed under the pendulum. A circle is inscribed on it to mark off in degrees the measurement of rotation in a given period of time. A thorough explanation of the history and outcome of the experiment was necessary for an effective understanding of the demonstration.

Spectroscope Demonstration

The examination of the various spectra with a diffraction grating spectroscope is a student activity which answers the frequent question, "How do astronomers know what stars are made of?" The spectroscope [5] may be constructed by the students themselves with the following materials: a card-

Four-inch reflecting telescope with its component parts mounted on a board was constructed by the author and his students.



Obervation of sunspots is made possible by projecting the image of the sun on a white screen by means of a pair of binoculars clamped to a standard ringstand.

[3] Available from the Welch Scientific Company, 1515 Sedgwick Street, Chicago 10, Illinois.

[4] Richard M. Sutton. "Demonstration Experiments in Physics." McGraw-Hill Book Company, Inc., New York. 1938. p. 90; Thomas E. Thorpe, Jr. "Project Pendulum." *STAR '60 Selected Papers in Science Teaching*. National Science Teachers Association, Washington, D. C. 1960. p. 31; and Stong, *Op. cit.*, 198:115, June 1958.

[5] Fletcher G. Watson. "Shoebox Spectroscope." *Tomorrow's Scientists*, 3:4. January 1959.

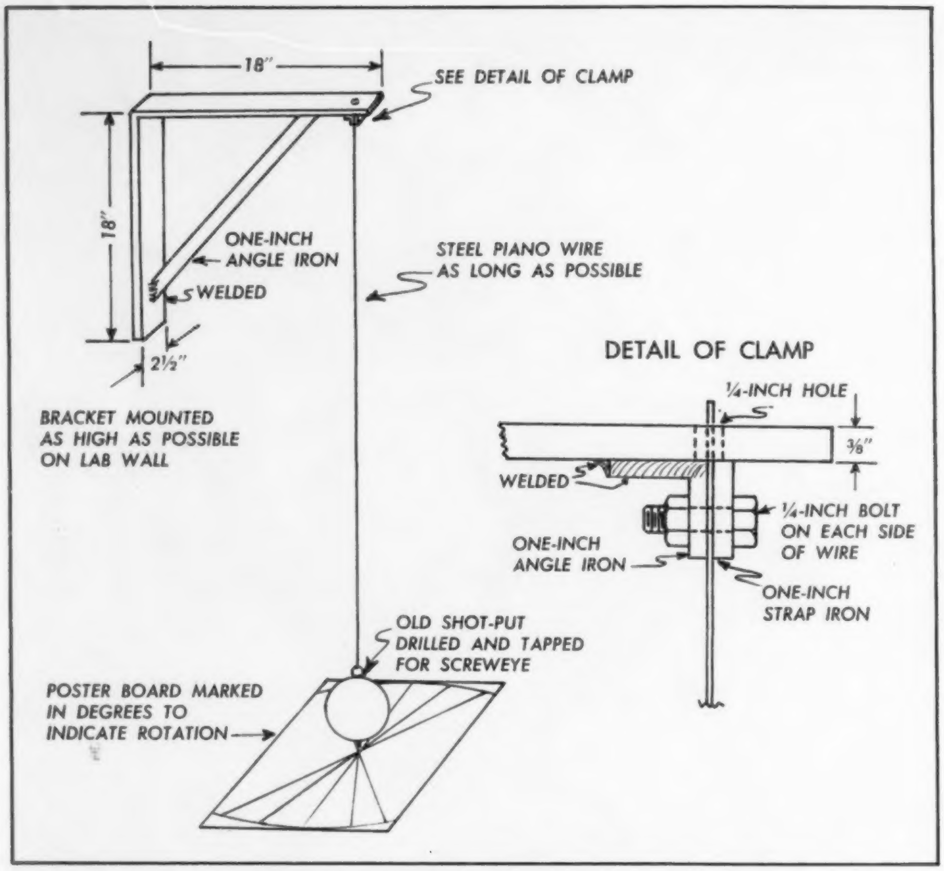


FIGURE 1. Detail of Foucault pendulum.

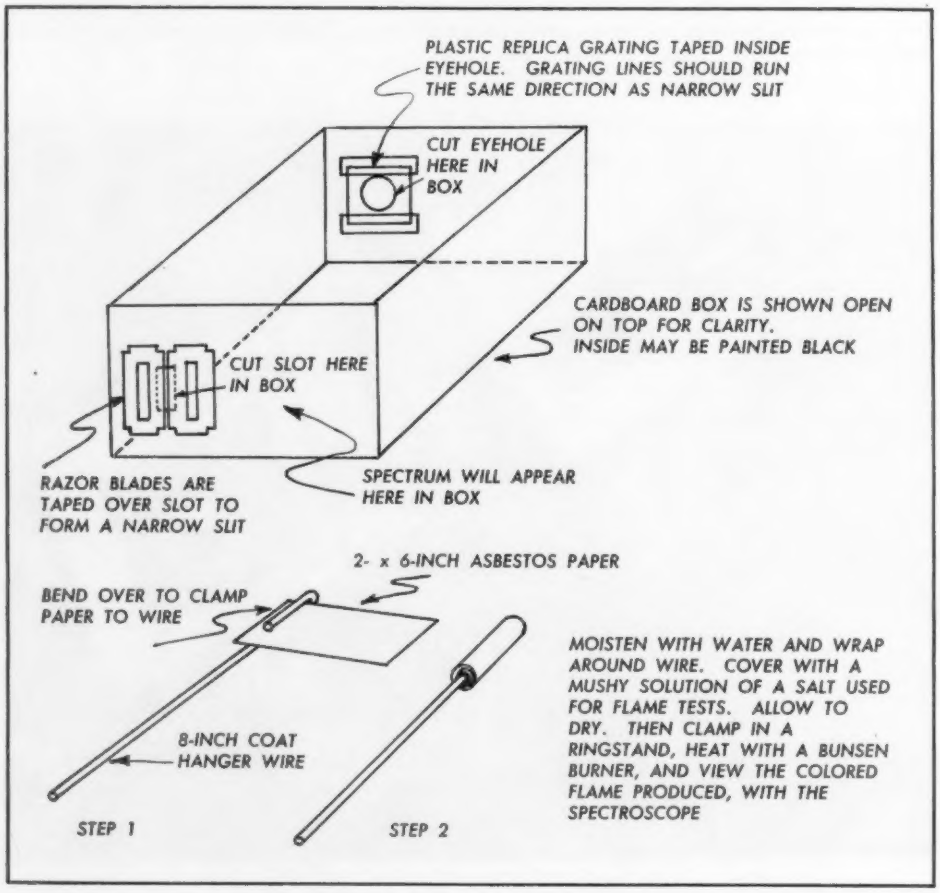


FIGURE 2. Detail of spectroscope and spectra sources.

board candy box, two razor blades, a replica diffraction grating, and Scotch tape.[6] A slot about ¼ inch wide and 1 inch long was cut near an edge of the box. Two razor blades were taped over this slot so that their edges formed a narrow slit about ½ to 1 mm wide. An eye hole, ¾ inches in diameter, was cut at the other end of the box, and a piece of the replica grating was taped inside this hole. The grating lines should run in the same direction as the slot. The spectra appear on either side of the slot when viewed through the eye hole. (See Figure 2.)

The spectra sources for this activity were produced from a piece of asbestos paper about 2 inches long by 6 inches wide clamped to a coat hanger wire about 8 inches long. The paper was moistened with water and wrapped around the wire. A mushy solution of each salt used in flame tests—sodium chloride, strontium chloride, etc.—was mixed, smeared over the asbestos paper, and allowed to dry. The specimen was then clamped to a ring stand and heated with a Bunsen burner.

The spectroscope may also be used to examine neon signs or fluorescent lights for a comparison of the spectra produced from these sources.

Time Measurement

Many texts mention the importance of time measurement in astronomy. The author supplemented the information in the textbook by the following method. Since the Bureau of Standards, Station WWV, and the Naval Observatory broadcast a continuous standard-time signal for the United States, the students were assigned to listen to this broadcast and determine its pattern in order to draw some conclusions. For this purpose, a short-wave receiver for signals of three wave lengths (2.5, 5, or 10 mc) was needed. The time broadcasts occurred at five-minute intervals with the first, second, and third minutes carrying a tone signal. Each second was denoted by a beep; the fifty-ninth second was omitted, and the sixtieth was indicated by a double beep. The announcer gave the standard time at the start of a tone signal before the end of five minutes. A new five-minute interval was begun, and the procedure then repeated.

[6] Plastic replica grating is available from the Edmund Scientific Company, Barrington, New Jersey.

The above experiment may appear over-simplified, but it is useful.

Other Activities

In addition to the experiments and demonstrations described, students in the astronomy unit learned to photograph star trails [7] and experiment with lenses and mirrors to determine how images are formed in a telescope. Through the use of simple thermocouples, an explanation was given as to how star temperatures may be calculated.

The author plans to expand the astronomy unit with some new activities involving "Measurement by Parallax," [8] "The Law of Equal Areas," [9] "A Pinhole Coronagraph," [10] and sunspot photography.[11]

[7] United Nations Educational, Scientific and Cultural Organization. *UNESCO Source Book for Science Teaching*. New York. 1956. p. 65.

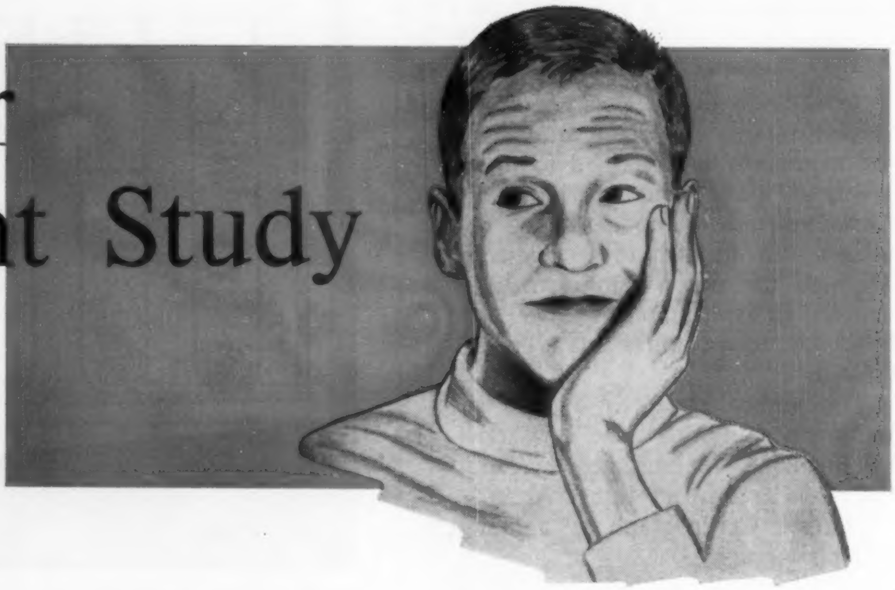
[8] Physical Science Study Committee. *Preliminary Edition of Laboratory Guide No. 2, Part 1*. Educational Services, Inc., Watertown, Massachusetts. August 29, 1958.

[9] Physical Science Study Committee. *Preliminary Edition of Laboratory Guide No. 3, Part 1*. Educational Services, Inc., Watertown, Massachusetts. December 15, 1958.

[10] National Academy of Sciences-National Research Council. *Planet Earth—Classroom Experiments*. Washington, D. C. 1958. p. 4.

[11] Robert W. Ferrell. "Sun Spot Photos." *Mechanix Illustrated*, 55:150. November 1959.

Criteria for Independent Study Projects



By **DONALD WYNANT HUFFMIRE**

Science Teacher, New Hartford Central School, New Hartford, New York

INDEPENDENT study is the pursuit of a special topic or project by the individual under the guidance of the teacher or other science educator as a part of the regular science course. It is not usually done in school. A project is a problem upon which a student works. It may require an empirical investigation. It may require doing an experiment, making a chart, making a model to illustrate a scientific principle, writing a report on a scientific article or book, or writing a report on a science topic of interest.

Science. The major project of the student should be in a scientific area. Science has many definitions. The authorities generally agree that science should be concerned with: (1) searching for knowledge or truth, (2) reflective, creative thinking about problems, (3) forming generalities from observations, empirically gathered evidence, and experiments, (4) using the inductive and deductive reasoning processes, (5) leading one to new concepts, experiments, and problems from each project solved. It is also concerned with methods of attack on problems, tactics and strategy by which problem solving and concept formation are carried out.

NOTE: Author is currently teaching earth science at North Syracuse Central School, North Syracuse, New York.

Educational and scientific objectives. Projects should help the teacher achieve the main objectives of science teaching. From the literature, it appears that educational objectives of science can be classified under these main headings:

1. To teach the different tactics and strategies of the scientist for solving problems and forming concepts.
2. To develop creativeness in students.
3. To provide for the individual growth of the student in knowledge, independent thinking, and self-direction.
4. To individualize instruction, thus helping each student develop in science to the utmost of his capacity and ability.

Students should be made to realize that there is no single scientific method, and that, in actual practice, scientists do not follow one particular method. They should learn to identify problems and solve them in order to form concepts.

Creativeness is the tendency of the individual to make novel adjustments. It is also the ability to synthesize previously unrelated elements of experience into a dynamic, unified whole. The authorities feel that all normal human beings have the capacity for creativeness.

Science instruction should make it possible for the individual to grow in knowledge, independent thinking, and self-direction. One of the most important objectives of science teaching is that the student should gain in knowledge. Individual thinking and the student's ability to plan and direct his own life are also important.

Since no two students are alike, there must be provision for the wide range of individual differences of all learners in their need and ability.

Evaluative Criteria for Science Projects

Student projects should be evaluated according to the objectives of science teaching. Unless one knows what to look for in a science project, evaluation is difficult.

Understanding the Tactics and Methods of the Scientist.

A scientific project should show that the student has used some of the tactics and strategies of the scientist in solving his problem and in forming new concepts. Some of the methods the student scientist could use are: (1) the planned investigation, (2) reflective thinking, (3) inspiration, (4) the "educated guess," (5) trial-and-error, (6) the chance discovery, and (7) reference to authority. The scientist may use some or all of these in his investigation.

The planned investigation. The planned investigation should include some or all of the stages of scientific inquiry. It might include some or all

of the following: observing nature or surroundings; describing and classifying data; recognizing a problem; using inductive logic to devise experiments and test hypotheses; making use of the control in an experiment; and using deductive logic when laws are discovered or assumed.

Reflective thinking. Reflective thinking may be used in many phases of the investigation. Reflective thinking is that kind of thinking which may appear when a problem arises that finds no ready solution. According to the literature, the student who is skillful in this kind of thinking can discover and clearly define problems. That is, he is curious, but does not try to solve problems for which there are no data; he differentiates between authoritative and nonauthoritative sources of information; he observes accurately in laboratory or field work; he shows discrimination in the selection of data and reasonably interprets the data; he selects the hypothesis which best explains the data; he reaches justifiable conclusions which do not claim too much or too little from the data; he is resourceful in attacking the problem and flexible enough to criticize his procedures at any point and to revise his tactics and strategy; he can formulate and carry out a plan of action even if it is based on inconclusive evidence and tentative judgments; he recognizes the possible existence of errors in measurement.

Inspiration. Associated with reflective thinking, another scientific method for attacking problems successfully is inspiration. There are five stages in this method. They are: preparation, incubation, intimation, illumination, and verification. During the preparation stage, the problem is investigated in all directions. In the second stage, there is no conscious thinking about the problem. Preceding the illumination stage, there is a moment when the individual realizes that the answer is coming. During the verification stage, the validity of the idea is reduced to exact forms by conscious use of discipline, attention and will.

The "educated guess." When a scientist uses an "educated guess" to solve a problem in an investigation, he is really playing a hunch. This method is used when there is no apparent solution to the problem. It is based upon knowledge about the problem. Muscular dystrophy and the Bohr theory of the atom were discovered by this method.

Trial-and-error. The trial-and-error method is used by the scientist when he does not have any clues for the solution of a problem. The scientist tries different procedures in attempting to solve the problem. It is usually a slow and unsatisfactory method. Though unscientific, it is still the method best suited for certain kinds of science problems. New antibiotics and quinine were discovered by this method. It is also being used in the fight against cancer.

Accidental discovery. New concepts may be discovered by the scientist accidentally. Some of these concepts led to the discovery of Uranus, the development of penicillin, the discovery of the cause of diabetes, and the discovery of X rays by Roentgen.

Reference to authority. The work of past investigators should be referred to during the investigation. Immediately upon starting the research, the young scientist must read as much about his area of investigation as possible. As he reads, the student should make observations and initiate experiments. However, it is not scientific to use library research as the only tactic in solving a problem.

Developing new concepts, problems. Any scientific investigation should result in the formation of new concepts and problems for the investigator to work on.

Using a logbook. One of the most important means of evaluating the student's tactics and strategy in problem solving is by analyzing his logbook. A scientist should make a record of all he does. He can never tell at the moment of observation whether some occurrence will later be important to his conclusions for the project.

Making a final written report. Since it is necessary that a scientist pass on his information to others, a written report should be included as a part of the science project.

Achievement of Creativeness.

Creativeness is important in all aspects of project work. According to the literature, formulating the hypothesis is the most creative aspect of research—whether the hypothesis relates to defining a problem, to determining a mode of attack, to establishing categories for data, or to making deductions.

Other Kinds of Individual Growth for the Student.

In evaluating the individual growth of the student, such things as knowledge gained and grasp of the subject being studied, self-direction, independence of thinking, and the mental approach to the problem should be considered.

Through questioning, the student's understanding of the subject being investigated should be determined. He should have a good understanding of his particular field.

An important responsibility of education in a democracy is to promote the student's ability to plan and direct his own life. If while working on a project, a student has used his time efficiently, employed efficient work habits, mastered the necessary working skills or abilities, was not easily distracted, was neat, orderly, and thorough in his work, then he has demonstrated his capability for self-direction.

The student demonstrates independence in his project when he questions authority, not rebelliously, but in terms of the qualifications of that authority; when he discovers his own facts and hypotheses instead of being forced to depend on others for their thoughts; when he maintains reservations in accepting the conclusions of others until he has made his own investigations; when he maintains an open mind and is willing to change his opinions when confronted with new evidence; when he is tolerant of the opinions of others; when he is skeptical about his own generalizations and hypotheses and continually strives to substantiate them; and when he checks and rechecks the data in attempting to resolve any conflicting conclusions.

The literature indicates that in order for a person to succeed in science, he must have the proper mental qualities. Genius is not necessary. The attributes needed are clarity of mind, a combination of imagination and caution, of receptivity and skepticism, of patience and thoroughness, and of ability to finalize, of intellectual honesty, of a love of discovery of new knowledge and understanding, and of singleness of purpose.

To summarize, the evaluation of an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independent study project in science should be based upon the methods and tactics used, the creativeness expressed, and the individual growth of the student scientist.

Specifically, in evaluating the tactics used by the student scientist, it should be determined whether the tactics used were appropriate for the problem. Since no two problems are alike, no one method can be applied invariably to all problems.

Other things to consider in evaluating the tactics used are: (1) whether the problem was stated simply, clearly and concisely, (2) whether the investigation was planned well, (3) whether the investigation was carried out well, (4) whether the observations were empirically obtained by observations and experiments, (5) whether the observations were accurate, (6) whether the data were grouped and classified properly, (7) whether the hypotheses formed concerning the solution of the problem accounted for a fair part of the available information, since some of the data might be incorrect or irrelevant, (8) whether the apparatus was designed appropriately for the experiment, (9) whether the apparatus works properly, (10) whether the student has tested each of his hypotheses and eliminated the ones which do not help to solve the problem, (11) whether he tested his ideas again and again, and checked them against the work of others, (12) whether objective measurements were used, for which the limits of accuracy were known by the student, and subjective measurement clearly described, (13) whether the observations and experiments can be verified, (14) whether the concepts formed from the data and from the solution of the problem were sound, and (15) whether new problems and experiments were suggested from the solution of his problem.

Creativeness should be evaluated by analyzing the student's logbook. It should be evaluated in terms of the manner by which the student's problem originated, how the hypotheses were formed, how the hypotheses were tested, how the data were collected, organized and interpreted, how the generalizations were drawn, how the apparatus was designed and improved, and how the conclusions were drawn and whether or not new concepts, experiments, and problems for future work resulted from the total effort.

Classroom IDEAS

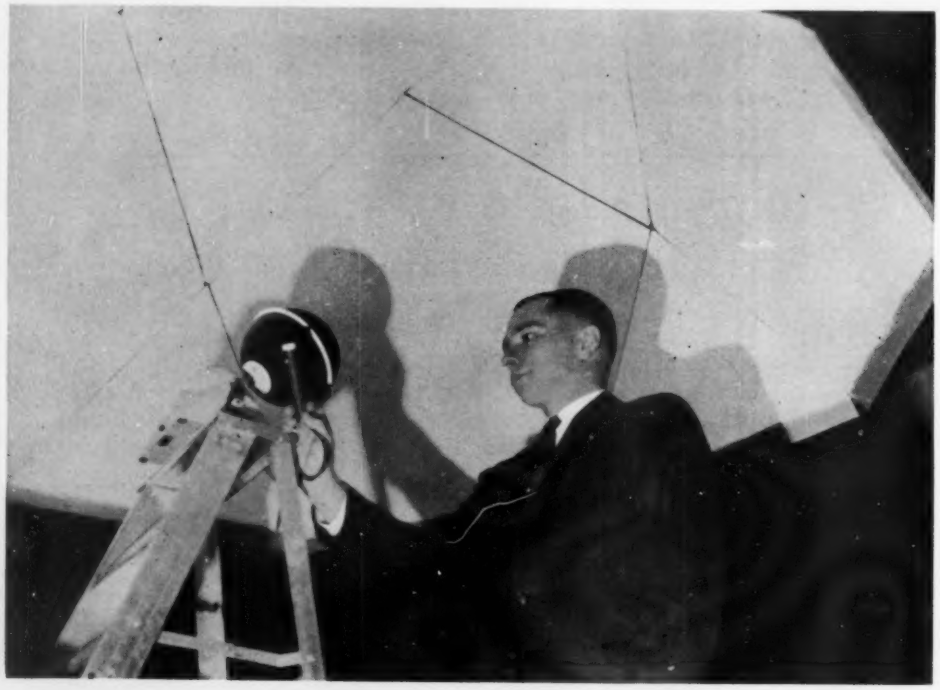


FIGURE 1. The dome, nearly hemispherical, provides about 6.5 square meters of projection area.

FIGURE 2. The structure incorporates ten triangles, making it rigid and lightweight.

General Science

An Inexpensive Planetarium Dome

By WILLIAM M. THWAITES, Walter Colton Junior High, Monterey, California

A planetarium dome can be built of corrugated cardboard at nominal cost and can be stored flatly during periods when not in use. This dome when used with a low cost commercially available star projector can provide an economical stimulus in the teaching of elementary astronomy.

The need for providing a stimulating experience in space science is made clear by daily newspaper headlines. A planetarium can provide a learning experience in some ways that surpass direct observation. Unfortunately few schools have been willing to put up with the expense and inconvenience of providing such an installation. Essentially any expense and many of the difficulties can be avoided with the combination suggested here.

The dome is intended for use with a low cost star projector available through toy stores, as well as through some scientific equipment companies. This projector cannot be used alone in a normal partially darkened classroom. A dome of some sort must be provided in order to make the star images clearly visible. In addition, the dome provides a realistic likeness to the celestial sphere observable in nature. (See Figure 1.)

The structure pictured here is about two meters in diameter and easily accommodates fifteen students plus the teacher. It has a semi-regular polyhedral shape requiring the use of six pentagons and ten triangles, one-half of an icosidodecahedron. (See Figure 2.) Each face is regular with all sides measuring sixty-five centimeters. The faces were flanged and fastened with Acco No. 22 paper fasteners. (See Figure 3.) The inside was painted with flat white paint to provide an optimum projecting surface and the entire structure was suspended by pulley from the ceiling. When the dome was not being used, it was quickly lifted out of the way. At the conclusion of the astronomy unit it was taken apart in a few minutes for storage.

This simple structure made it pos-

FIGURE 3. Flanging adds strength and a means of fastening the faces together.

sible to demonstrate not only identification of star groups, but also diurnal motion of the stars, celestial poles, celestial equator, meridian, zenith, horizon, latitude determination, and other spacial concepts normally impossible to demonstrate. Expense and inconvenience should not be deterring factors in providing this space experience in our space age.

Teacher-Made Slide Rule

By WILLIAM MacDONALD, Horace Mann Junior High School, Brandon, Florida

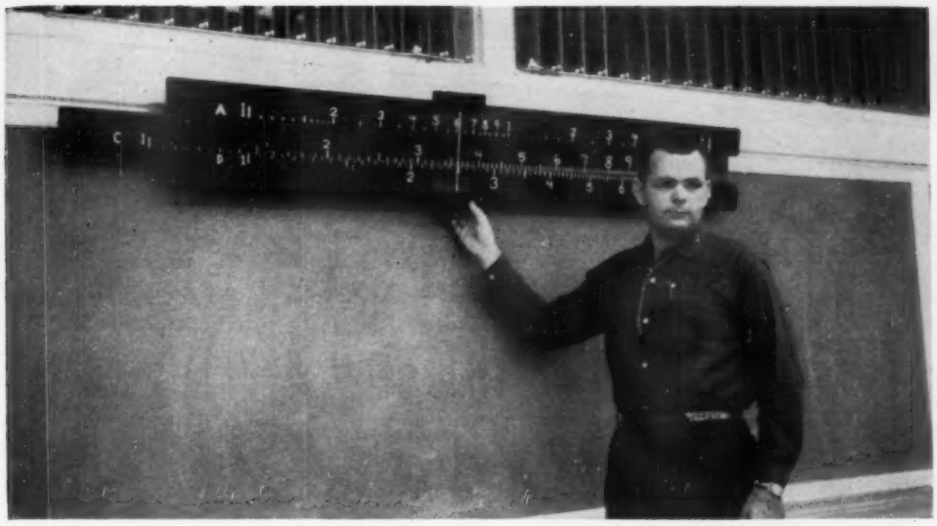
Have you avoided teaching use of the slide rule in class because you were unable to obtain some funds to purchase a demonstrator? Although many teachers are forced to omit this from their schedule, it does not solve the problem nor help increase the knowledge of the student. One way to solve the problem, however, is to construct a slide rule, and any teacher can do this in spite of limited funds.

First, procure three six-feet lengths of straight tongue-and-groove flooring. These should fit snugly together when interlocked. Lay these three pieces flat on the floor, side by side, loosely interlocking the tongues and grooves. This is necessary to permit free sliding. For supports, cut three strips of similar wood long enough to reach across the total width of the three boards. Nail these strips into the top and bottom boards at three uniform distances along the slide rule, allowing the middle board to slide freely. Some trimming of the tongues and grooves may be necessary to obtain free slippage. A carpenter's plane or pocket knife may be used for this purpose. Further ease of movement may be obtained through the use of powdered graphite serving as a dry lubricant.

The final stage of the woodwork is to rip a six-inch length of flooring in half to slide above and below the rule and house the clear plastic indicator. Six by twelve inches is a desirable size for the plastic indicator which may be obtained from any hardware store. Screw the plastic indicator to the runners on either side.

Now, the frame is completed, and the whole rule should be painted with one or two coats of flat black paint. All that remains by this time is the scaling. With an ordinary ruler, measure the distance between two major units on a ten-inch slide rule. Multiply that distance by six and lightly mark the result on the face of your slide rule. Continue this method until all major divisions are indicated on one scale of the rule. You will now have a sixty-inch face on the slide rule. The secondary digits may be added in a similar manner. The tertiary markings can be approximated. Paint points and numbers on the rule with white paint.

As many additional scales may be added to the rule as the teacher would like. The rule pictured, however, is



Author demonstrates the proper use of his constructed slide rule.

used at the eighth-grade level, and the writer preferred not to complicate it with scales that the average eighth grader would not comprehend. This rule can be used for multiplication, division, square root, and ratio and proportion.

The total cost of the rule was: Flooring—0.75; plastic—0.75; graphite from pencil sharpener (no cost); paint and miscellaneous expenses—0.35; or a total of $1.85 for the materials. It took twelve hours of the teacher's time. But you have a demonstration tool that can be used throughout the year, and possibly for several years. This alone minimizes the time spent by the teacher on the project. It is not unlikely that your students could construct the rule with your help to cut down on even the twelve hours you might spend.

Chemistry

The Use of Unknowns

By T. W. JEFFRIES, Kelso High School, Kelso, Washington

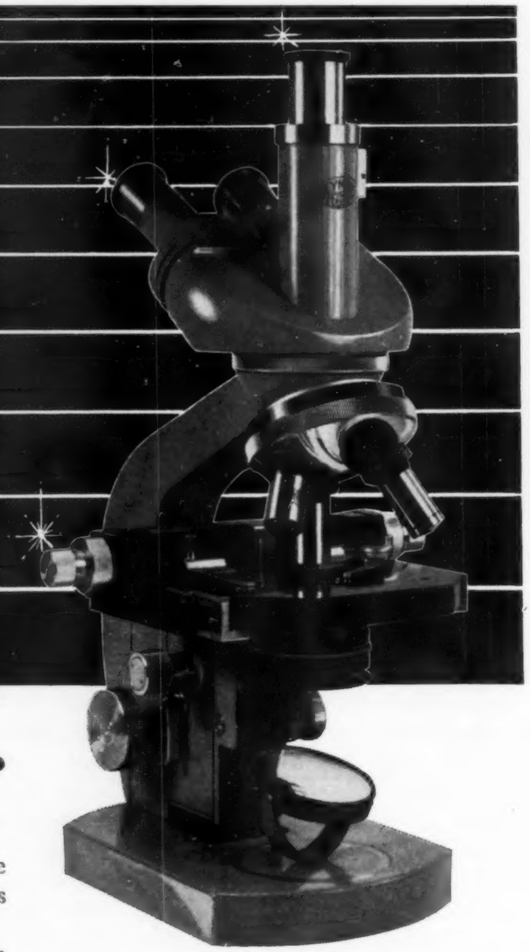
Frequently, the student parrots definitions of elements, mixtures, and compounds without understanding the differences which each exhibits. In an attempt to overcome this, the author has devised an unstructured laboratory experiment to point up the differences.

The student is told that in several weeks he will be given an envelope containing a substance which is a mixture, a compound, or an element. The actual experiment is not introduced, however, until the basic laboratory techniques, such as filtering, bending tubing, etc., are completed. Only general information is given on procedures and references to be followed.

In a written report, the student is required to explain how he arrived at his decision. His grade is based on the laboratory results and whether he is able to make an identification. The highest grade is given for a correct answer with logical laboratory results. The next best grade is earned by an incorrect answer with good laboratory results. Finally, the lowest grade is assigned to an unsupported right answer or the wrong answer with the correct evidence.

In making the unknowns, the author attempted to choose mixtures that were homogeneous and would not give visual evidence. A suggested list might include: commercial fertilizer, baking soda, baking powder, calcium carbonate, colored chalk, colored chalk and sulfur, clay, sugar, salt, sugar and salt, carbon, manganese dioxide, carbon and manganese dioxide, anhydrous copper sulfate, cement, albumin, ferric oxide, ferric oxide and red phosphorus, or magnesium oxide and calcium carbonate. The varieties and combinations are inexhaustible.

The students entered into the spirit of investigation, and the results were most satisfactory. Although only a few obtained correct answers, all of the students seemed to have a better understanding of elements, mixtures, and compounds.



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NSTA Activities

Elections Report, 1961

Members of the Association gave support to six new candidates as more than 4200 ballots were cast in this year's election to choose two officers and four regional directors. The remaining officers and directors of the current Board complete the second year of their terms. (See 1960 elections, May TST.)

Returns were sent in promptly to the Headquarters Office by the Elections Chairman. Together with the Chairman, John P. Harville, we express our appreciation to the Committee and members for the excellent cooperation and interest and extend congratulations to the newly elected officers and directors who are listed below.

President-elect — John H. Marean, Reno High School, Reno, Nevada (1961-62; to serve as President 1962-63).

Finance Officer—Frederick R. Avis, Saint Mark's School, Southborough, Massachusetts (1961-63).

Region I. Director—Elizabeth Ann Quinn, Saxe Junior High School, New Canaan, Connecticut (1961-63).

Region III. Director—H. Craig Sipe, George Peabody College for Teachers, Nashville, Tennessee (1961-63).

Region V. Director—Walter E. Hauswald, Sycamore Community Schools, Sycamore, Illinois (1961-63).

Region VII. Director—Rodney F. Mansfield, State Department of Education, Denver, Colorado (1961-63).

Convention Notes

"Tremendous!!!"—that is the word for the NSTA Ninth Annual Convention at Chicago this year. The total registration reached 2710, which is nearly 900 more than the previous high established at Denver, Colorado in 1958. In addition, this represents a 50 per cent increase over last year's high in the number of commercial exhibits that were on display. There were a total of 148 booths in Chicago. The closed circuit TV, which operated 12 hours every day, proved to be a successful innovation of interest to all participants.

With the program of the Chicago convention still fresh in our minds, we also remember the session of next year's committee members already at work planning the 1962 convention to be held at San Francisco, March 9-14. These alert observers of the committee even made use of the TV event to spot certain members and get them to sign their commitments. Leaders in the Bay area have set as their attendance goal a minimum of 2710 *plus* 1.

Chicago Convention Proceedings

The NSTA convention proceedings of the 1961 sessions will not be made available to the membership this year. The task of preparing these proceedings has generally been assigned to the membership in the field. The planning this year, however, did not include preparation of proceedings and we are, therefore, alerting you of this change.

Regional Conferences, 1961

Southeastern Meeting

Continuing a report on the series of regional conferences, NSTA will schedule the fourth at the University of North Carolina, Chapel Hill, on September 7-9, 1961. "Learning Science as an Individual Experience" will be the theme of this conference. Lectures and discussions will emphasize related processes and the role of the learner in the progam. Small group discussions will be held in order to aid teachers, supervisors, and administrators to participate in an analysis of the individual problems in this area. The influence of current scientific emphases upon the learner, the effects of current teaching materials, problems of motivation, problems of the atypical learner, and the influence of community and national social scientific problems are examples of the range of topics to be included in the program.

Registration for the conference will begin on Thursday evening at 7:00 p.m.

in Peabody Hall on the campus of the University. Following registration, a session planned especially for administrators and supervisors is scheduled. Commercial exhibits may be viewed on Thursday evening.

On September 8, Friday, registration with viewing of exhibits continues from 8:00 a.m. to 9:30 a.m. The opening session is to follow with the keynote address. After the twelve noon luncheon, special interest group sessions will be planned. The banquet is from 7:00 p.m. to 9:30 p.m. after which a planetarium show will be given.

On September 9, Saturday, registration and exhibits are open from 8:00 a.m. to 9:30 a.m. The general session to follow will be a symposium on "Helping the Elementary School Child Learn Science" and "Helping the Adolescent Learn Science."

Special group sessions begin at 11:00 a.m., followed by State group meetings to begin at 12:30 p.m.

For a final program and for room reservations, write to the Chairman, John B. Chase, Jr., School of Education, University of North Carolina, Chapel Hill, North Carolina.

Midwestern Meeting

The fifth NSTA Regional Conference will be held at the new Nebraska Center for Continuing Education, University of Nebraska Agriculture Campus, Lincoln, on September 22 and 23, 1961. With the co-sponsor, Teachers College of the University of Nebraska, we invite participation of all science teachers from Nebraska, Iowa, South Dakota, Wyoming, Colorado, Kansas, and other interested states. Focusing on three aspects of improving science instruction, the conference will cover (1) The Learner—Implications for Science Education, (2) The Subject—Science for Today's Children and Youth, and (3) The Teacher—Promising Practices in the Classroom and the Laboratory.

On Friday, September 22, early morning field trips will be scheduled concurrently with selected new science teaching films. The first general session will start at 10:30 a.m. with an address on youth as *learners* in science. This will be followed by a luncheon.

The second general session, after the luncheon, will include a speaker covering the topic of "children as learners in science." From these main topics, group discussions will be organized in separate sections. Concluding will be the banquet session that starts at 6:30 p.m.

Saturday, September 23, the sessions begin at 8:30 a.m. Two addresses are scheduled for this third general session. They will relate to the subject matter of science for use in the elementary school and for the secondary school. Following this session, section meetings will be organized for elementary, biological, and physical science teachers. The noon-day luncheon will be devoted principally to NSTA Activities.

"Outlines of promising practices in the classroom and laboratory" will be the subject of the fourth general session. Discussions on specific teaching techniques and materials will bring the final session to a close. For further information write directly to the Chairman, James A. Rutledge, University High School, University of Nebraska, Lincoln 8.

Upper North Central Meeting

With "The Learner in Focus" as the theme for the sixth Regional Conference of the upper north central area, science teachers will have ample opportunity for a lively exchange in discussions of curriculum from kindergarten through grade twelve. To be held in Minneapolis, Minnesota, the three-day meeting will begin by registration on Thursday evening, September 28, 1961, at the Vocational High School Auditorium located at Twelfth Street South between Third and Fourth Avenues. Exhibits, teacher-planned programs of "Here-is-How-I-Do-It" demonstrations and discussions for classroom teachers of: early elementary learners (K-3), later elementary learners (4-6), junior high general science learners, biology learners, physics learners, and chemistry learners.

The sessions for Friday, September 29, and Saturday, September 30, will be devoted to presentations and discussions of some dynamic problems of "the learner" as an individual in our science classrooms.

Dr. Gordon Mork, educational psychologist and former high school science teacher, will focus our attention on the learner as an individual. He will describe how the learner acquires mental understandings and how we can teach him to think critically and creatively. Discussion groups will review examples of direct teaching in the light of Dr. Mork's presentation.

Dr. Ellsworth S. Obourn, science specialist with the United States Office of Education, will address the Conference on the topic, "Developing a Junior High School Science Program for the Learner." In his presentation, he will describe valuable junior high school science programs which are in use, promising directions which may be used in developing a dynamic science program, and learning activities which should be used to implement a new science program.

Dr. Milton Pella, professor of science education at the University of Wisconsin, will discuss and demonstrate to elementary teachers of science, "Developing Science Concepts with the Learner in the

Elementary School." Dr. Pella will explain the directions which elementary school science programs, K-6, are taking, and during his workshop will suggest ways in which the elementary teacher can help the learner.

At the Friday evening banquet (September 30) we will have the privilege of hearing Captain Joe Kittenger of the Air Research and Development Command, who will bring the latest information on projects, "Man High" and "Mercury." Many will remember the event of last year in which Kittenger parachuted from a balloon at 84,000 feet.

Exhibits by manufacturers of science equipment and publishers will be open for inspection from Thursday evening through Saturday noon.

Classroom teachers of science from kindergarten through grade twelve, and supervisors, are invited and urged to attend this three-day Conference. It is for the benefit of all interested teachers; but especially for the teaching personnel in North Dakota and South Dakota, Iowa, Wisconsin, Minnesota, Illinois, and our Canadian neighbors in the Provinces of Manitoba and Western Ontario. Mark the dates *now* and initiate a request to attend the Conference through your principal and superintendent. The registration fee is $2.

For further information and advanced registration write J. Hervey Shutts, Chairman, Upper North Central Regional Conference, Minneapolis Public Schools, 807 N.E. Broadway, Minneapolis 13, Minnesota.

International Activities

Youth Science Study Tour

The five student members of NSTA's delegation to Great Britain have been selected. They will attend the 1961 International Youth Science Fortnight to be held in London July 21-August 4 (see *TST* for March, p. 43 and for April, p. 57). These students, along with some 600 others from 15 different countries, will take part in an extensive program of addresses, panels, visits, and other activities arranged by the Worldfriends of Great Britain with cooperation of the British Association for the Advancement of Science. Each of the U.S. students has been awarded a $350 stipend by Scholastic Magazines, Inc., to help defray costs. Following the London conference, the NSTA group, including their leader, Dr. Millard Harmon, will visit places of special scientific interest in the Netherlands, West Germany, Switzerland, and France. They will travel in a Ford station wagon provided through the courtesy of the International Staff of the Ford Motor Company. Upon returning to the United States, various members of the group will report their experiences through articles in *The Science Teacher, Science World, Student Life,* and other youth publications.

Chris Cherniak is sixteen years old, lives in Eau Gallie, Florida, and is in the eleventh grade (in upper ten per cent of his class) of Melbourne High School. Particularly interested in neurophysiology, Chris has already studied advanced placement biology and Physical Science Study Committee physics and was vice president of the Florida Junior Academy of Science. His father is a guided-missiles engineer. Chris plays the clarinet, loves to swim and sail, and is now studying Russian and has had two years of Latin.

Joyce Meyer, daughter of a Colorado farmer, is a sixteen-year-old junior from College High School, Greeley, Colorado. Besides being a leader in many school, church, and local activities, she is Teen Talk Editor of the *Colorado Rancher and Farmer*. Through this medium, she plans to write a column about her international experience with other young scientists. One of her ambitions is to speak next year to the Colorado-Wyoming Junior Academy of Science. Her interest for science began in the field of entomology. Her "Study of the Ant" won an award at the Weld County Science Fair. In addition, she has been honored with second place and two champion awards at the 4-H Junior Fair. Joyce hopes to continue her studies in biological sciences through college and into research.

Edward G. Fisher, III, of Golden, Colorado is a seventeen-year-old science student in the eleventh grade at Golden High School. He is an active member of many science groups with special interests in physics (now enrolled in PSSC course), mathematics, and rocketry. Through his father, a professor of English at the Colorado School of Mines, Edward has become acquainted with students from abroad and shows an active interest in other cultures. He has been to

Canada and Mexico. His hobbies include reading, photography, and sports, especially swimming. Edward looks to a career in science or engineering. He has set his goal to complete a Doctorate.

Sheila L. Grinell, 16, of New York City, attends The Bronx High School of Science. She is an outstanding student (ranks highest in her junior class) and has worked on a number of science projects. These included work on a device to measure plant metabolism, co-author of articles, *Arista* tutor in chemistry, and lecturer before the Association of Mathematics Teachers on new concepts in geometry. One of her future goals is to present modern concepts of ancient geometry to her colleagues. Sheila is a member of the elementary and advanced chemistry clubs, of the Forum, and the Student Organization Art Publicity Committee. Her activities as a Girl Scout have given her opportunities to exchange views with her international counterparts. She says: "I hope to enlighten and, in turn, be taught by the world's young scientists."

Charles K. Holloway is a sixteen-year-old junior from Castlemont High School in Oakland, California. He has been enrolled in the honors program for the top two per cent of the students in his class since junior high school and has consistantly demonstrated his outstanding abilities especially in general biology, chemistry, genetics, and embryology-ecology. He is a member of the Gifted Life Science Class, the school ROTC band, concert band, orchestra, and a member and manager of the school swimming team. His science project, "Production of Polypeptides from Inorganic Material," received first place at the Oakland Science Fair and second place at the San Francisco Bay Area Science Fair. The son of a United States Navy Surgeon, Charles is well acquainted with travel and peoples of many countries and has developed a keen interest in foreign affairs. He hopes to continue his studies in college.

Staff Changes

Margaret J. McKibben has joined the staff of the Instructional Services and Organization Division of the U. S. Office of Education as an Assistant Specialist for Secondary Science. Her responsibilities will include participation in the research program in secondary school science, preparation of service leaflets and bulletins, and professional consultation.

During the past three years Dr. McKibben held the position of Assistant Executive Secretary for Special Projects of NSTA. She also served as Editor of the *Elementary School Science Bulletin* and was Director of the study, "*New Developments in High School Science Teaching,*" published in 1960 by NSTA. Prior to her NSTA position, she was a teacher of biology at the Oak Park and River Forest High School, Illinois. Dr. McKibben completed her graduate work in biology and education at the University of Pittsburgh. Congratulations and best wishes go along to Dr. McKibben from the staff in this new endeavor!

Publications

Under the Publications Section which produces *The Science Teacher* and other NSTA publications, two newly assigned staff assistants have reported. Miss Phyllis Rose Marcuccio is the newly appointed Editorial Assistant, who comes to us from the New York City area where she had extensive experience in the graphic arts and production procedures related to magazine publishing. Oriented in the biological sciences, she served as Production Associate for a number of medical publications. A graduate of Bucknell University, Lewisburg, Pennsylvania, Miss Marcuccio received her AB Degree in art and biology.

Mrs. Jacqueline A. Fish, who was replaced by Miss Marcuccio, has left the Association and is happily celebrating the arrival of her first baby.

Mrs. Ruth Gunther, the new publications secretary, has had experience in various fields including medical and academic backgrounds. In the latter, she assisted with the editorial work of a secondary school publication for four years. Mrs. Gunther fills the position vacated by Miss Justine Burton who has assumed her new assignment with "Vistas of Science."

BEST SELLER EDITION!

Planning for Excellence in High School Science is a special NSTA publication aimed to assist teachers in analyzing and projecting for science education. It provides suggestions for basic policy directives to teachers, supervisors, administrators, and all concerned with curriculum development in science. 68p. $1. (Discounts on quantity orders.) Send orders to NEA, Publications-Sales Section, 1201 Sixteenth Street, N.W., Washington 6, D.C.

ATTENTION . . . ← NSTA Conventioneers

The Food and Drug Administration of the U. S. Department of Health, Education, and Welfare, Division of Public Information, Washington 25, D.C., reports loss in the mails of signed requests for publications from science teachers attending the NSTA convention at Chicago in March. If you were one of these persons who stopped at the Exhibit Booth No. 118 and filled out a request to receive FDA materials, please send a postcard directly to FDA at the location above with your name and address. The FDA offer included a Science Convention Pack with free materials.

As a regular feature of *The Science Teacher*, the calendar will list meetings or events of interest to science teachers which are national or regional in scope. Send your dates to *TST's* calendar editor as early as possible.

June 22-24, 1961: NSTA Regional Conference, University of Hawaii, Honolulu

July 7-9, 1961: Annual Business Meeting of Board of Directors, NEA Building, Washington, D. C.

August 25-26, 1961: NSTA Regional Conference, University of Utah, Salt Lake City

September 4-5, 1961: NSTA Regional Conference, Oklahoma State University, Stillwater

September 8-9, 1961: NSTA Regional Conference, University of North Carolina, Chapel Hill

September 22-23, 1961: NSTA Regional Conference, University of Nebraska, Lincoln

September 28-30, 1961: NSTA Regional Conference, Vocational High School, Minneapolis, Minnesota

October 6-7, 1961: NSTA Regional Conference, Bradford Hotel, Boston, Massachusetts

October 13-14, 1961: NSTA Regional Conference, Sheraton Hotel, Portland, Oregon

October 20-21, 1961: NSTA Regional Conference, Netherland Hilton Hotel, Cincinnati, Ohio

BOOK Reviews

Physics for the Inquiring Mind. Eric M. Rogers. 778p. $8.50. Princeton University Press, Princeton, N. J. 1960.

The purpose of this book, according to the preface, is to promote understanding of basic principles of physics and show the connected nature of these principles. It is also intended that the reader will be encouraged to think and draw conclusions rather than merely accept statements. In our opinion, the goal has been achieved. The book is in five parts: Matter, Motion, and Force; Astronomy, A History of Theory; Molecules and Energy; Electricity and Magnetism; Atomic and Nuclear Physics. Part one and Part four are treated thoroughly but in not too unusual a fashion. We were favorably impressed by the simple drawings and the questions. Part two is most interesting and informative. It shows the thinking process of some of our great scientists building upon the work of their predecessors. This is a thoroughly enjoyable history. Part five is modern and complete. This material is a *must* for persons desiring to remain abreast with developments in nuclear science. The reader is able to see the contradictions of existing theories and the theories which evolved in an attempt to overcome the inconsistencies. The insight and boldness of the genius leaves one breathless. A fascinating section on relativity is woven into Part three. Thought-provoking questions and drawings bring out the inconsistencies which led to Einstein's theory, and also give the reader an understanding of the theory. We feel that this book accomplishes its purpose. The non-scientist can learn the basic principles and gain an appreciation of the scientific method. Every science teacher should include this book in his personal library, and the elementary and well-rounded teacher of any subject might well do likewise. In brief, these reviewers found the book to be superior in every respect, and recommend it.

SARA H. CLEMSON
D. F. CLEMSON, JR.
College Area High School
State College, Pennsylvania

The Two Cultures and the Scientific Revolution. C. P. Snow, 58p. $1.75. Cambridge University Press, 32 East 57th St., New York 22, N. Y. 1959.

To be asked to review a book by C. P. Snow is exciting, especially when one agrees with most of what Sir Charles says. After reading *The Two Cultures and the Scientific Revolution,* one can only add emphatically, "I wish I had said that."

Actually, the title of the book indicates only half of what Snow has to say. He first points out that there are two cultures in this world ("this world" mainly referring to the United Kingdom and the United States), and that there is almost no communication or conversation between the two: the world of the "haves" and the world of the "have nots." On the one side are the USSR and the Western World, and on the other the vast hordes who are ill-clothed, ill-housed, and ill-fed. In brief, Snow is saying that if our two cultures—the traditional, classic one and the scientific, engineering one—do not get together and learn to understand each other, they will never be in a position, as the world of the "haves," to help very much in the improvement of the world of the "have nots." But those who live in the world of the "have nots" know that their lot *can* be improved and that it is possible for them to *have,* also. This knowledge creates an imminently dangerous situation. In fact, Sir Charles uses the atom-bomb explosion to illustrate his point. After the first explosion, it was not necessary to show others how to build the bomb, the demonstrated fact that it *would* work makes it possible for others to develop the knowledge without help. In the same way, the "have nots" look at the "haves" today and see that the industrial revolution and the science and engineering on which it is based have given us abundance. Knowing that the system will work, they will insist on having it, too. Whether they develop it within a framework of democracy or of communism is still a moot question; but, if we ignore the problem, we can only delay their progress or toss them into the Russian camp.

There are other areas where Sir Charles strikes even closer to home. He speaks of the high table at Cambridge, where the professors of literature and the arts could not speak to the mathematicians. In American universities, the classicists cannot speak to the physicists, and, indeed, the physicists, in many cases, cannot speak to the engineers. It has been my fate for the past thirty years as an engineer to have to listen to the classicists when they point out that engineers are uncouth and "uncultured." And, perhaps as a result of this goading, I have insisted that engineering education include some of the arts and the humanities. But slowly, too, there has been a dawning realization that the people on the other side of the fence knew nothing of what I was doing; and, to call themselves "broadly educated," *they* ought to know something about science and engineering. But yet, to this time, they have shown precious little inclination to do so. Perhaps under the prodding of the expert from out of town this will be changed.

Sir Charles not only defines the problem for us but also demonstrates, as with the atom bomb, that it can be solved. He himself operates easily and with outstanding effectiveness in not two but three worlds—science, literature, and government. In "The Two Worlds," he deals basically with critical sociological forces with the irrefutable logic of the scientist and the felicity of the accomplished writer. He has charted the course and has shown us that it can be traveled. For both, we are all of us deeply indebted. [See Audio-Visuals, page 61.]

ERIC A. WALKER, *President*
The Pennsylvania State University
University Park, Pennsylvania

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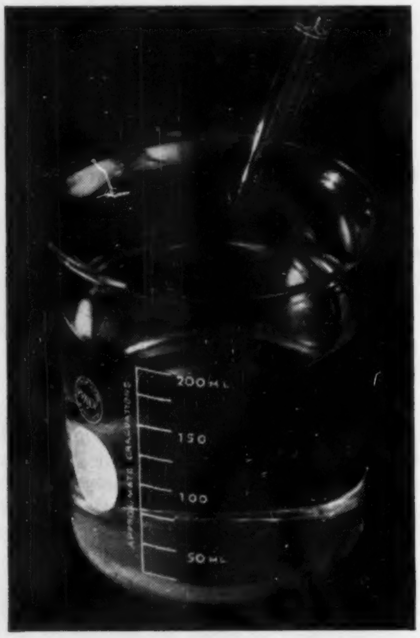

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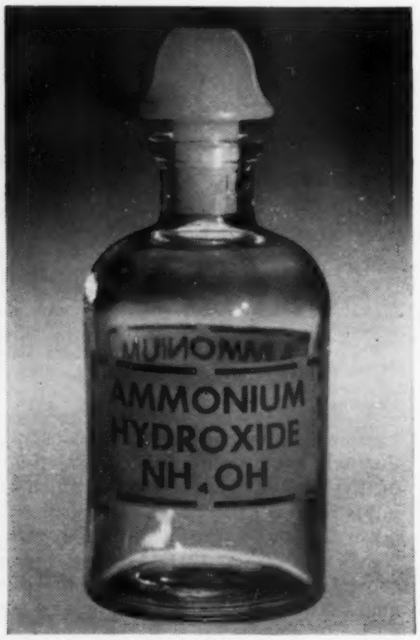

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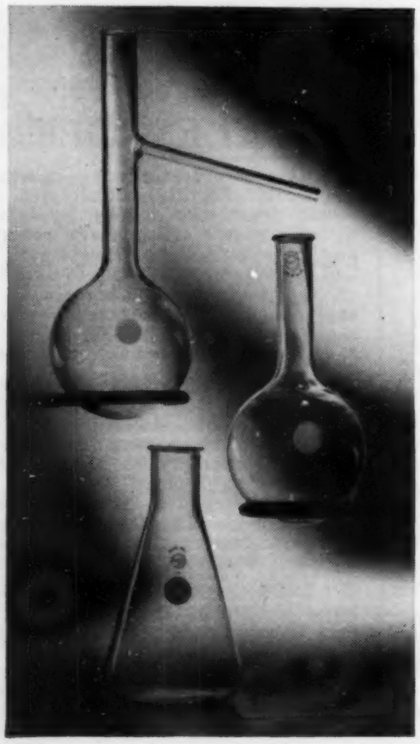

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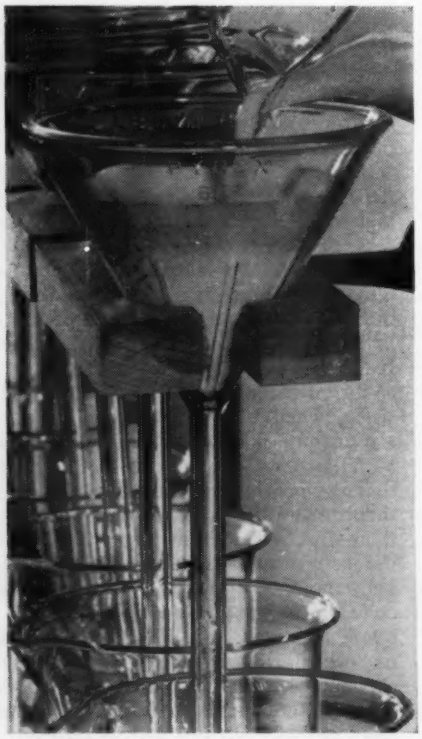

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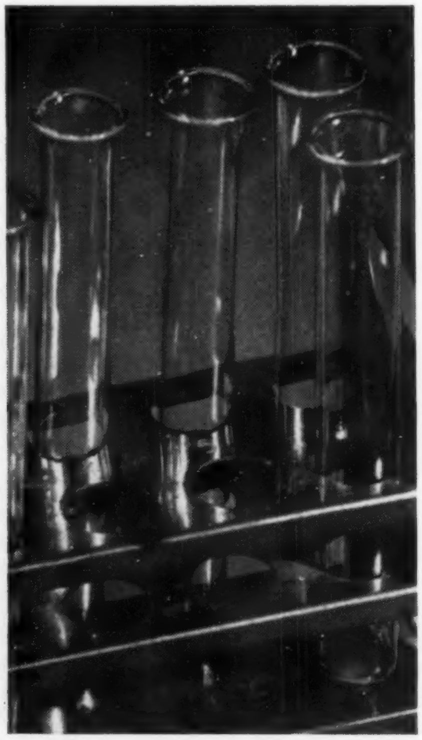

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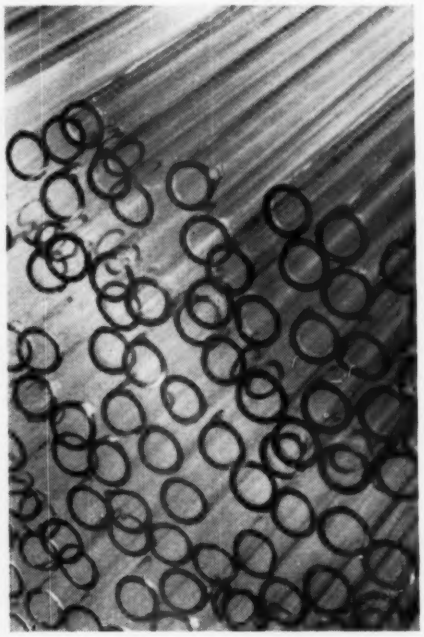

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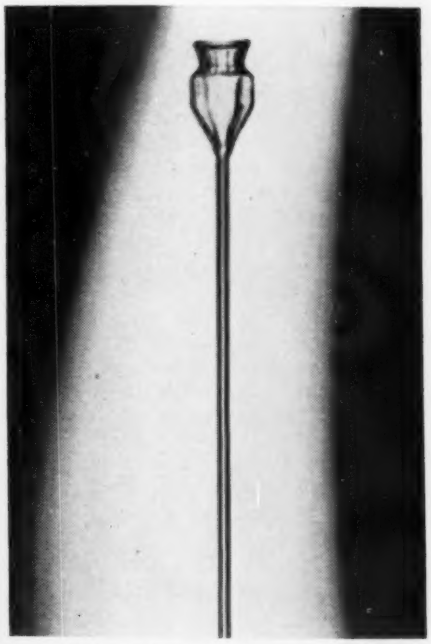

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BOOK BRIEFS

Science Today for the Elementary School Teacher. John G. Navarra and Joseph Zafforoni, 470p. $6.40. Row Peterson Company, Inc., 1911 Ridge Ave., Evanston, Ill., 1960.
Simply written text for the elementary school teacher. Contains appropriate content and a good amount of methodology. Covers most of the areas typical of elementary school science including air, weather, and aviation; space, time, and the earth; matter, energy, and life. Pattern and content not unlike other elementary science methods textbooks.

Satellites in Outer Space. Isaac Asimov. 80p. $1.95. Random House, Inc., 457 Madison Ave., New York 22, N. Y.
A volume in the new Easy-to-Read Science Books. Summary of important chapter headings follow: Satellites of Earth, Measuring Shape of Earth, Air at Edge of Space, Counting Meteors, Belts of Particles around Earth, Magnets and Paddle Wheels, Pictures of Outer Space, Messages from Satellites, Man into Space. Simplified subject matter in natural sequence; clearly names and explains functions, weights, and orbits of satellites; as well as the significance of data obtained. Introduces new terminology in easily understood manner. John Polgreen's clear, exact illustrations aid comprehension. A volume to capture and hold interest of science classes in grades 3-6.

Biology, A Basic Science. Elwood D. Heiss and Richard H. Lape. 690p. $5.56. D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J. 1960.
A variation of the scientific method in a basic text. Technical jargon held to a minimum and italicized. Glossary utilizes phonics for ease in pronunciation. Thirty-one chapters of twelve units cover animal behavior, man fights disease, reproduction, heredity, changes through the ages, interrelationships, conservation, and present biological problems. Each chapter presents two or three "problems." "Facts" are gathered in the chapter. Presents "reviews," and itemizes facts to be utilized in solving original problems. "Solution" tested by presenting a similar problem. Not a colorful book but basic material presented in factual manner.

Edison Experiments You Can Do. Prepared under the direction of International Edison Birthday Celebration Committee of the Thomas Alva Edison Foundation. 130p. Cloth $2.50. Harper and Brothers, 49 East 33rd St., New York 16, N. Y.
A book based on the original notebooks of Edison. An informative account is given of Edison's life from boyhood to death and the manner in which he worked. Contents include descriptive accounts and how to duplicate the following experiments: The Carbon Button, Speaking Telegraph, Insulation, Electric Light, Fuse, Wireless, Radio Tube, Electric Pen, Phonograph, and The Quadruplex. An excellent reference book for setting up experiments and demonstrations in science classes for junior high school students.

Mollusks, An Introduction to their Form and Functions. J. E. Morton, 232p. $1.40. Harper and Brothers, 49 East 33rd St., New York 16, N. Y. 1960.
A thorough and interesting coverage of the biology of the mollusks; this readable book fills a gap in the available reference books of Invertebrate Zoology at a reasonable cost. Taxonomy and general anatomy of mollusks are discussed, but the emphasis is on evolution and adaption of structures for the functions they perform (functional morphology). Recommended as an excellent reference book for college classes in zoology and for superior high school biology students.

Project Mercury. Charles Coombs, 64p. $2.75. William Morrow and Company, 425 Fourth Ave., New York 16, N. Y. 1960.
Presents the problems involved in placing a man in space and returning him to earth, as well as how this can be accomplished. Also described are the construction details of the various stages and about the capsule and fuels used for propulsion. Details of control in flight and transmission of information are discussed. Describes retrieving capsule from ocean after slowing by parachute. A good library book for elementary classroom to provide information about space flight.

All About the Planets. Patricia Lauber. 140p. $1.95. Random House, 457 Madison Ave., New York 22, N. Y. 1960.
A volume in the "All About" series. Covers classical theories on formation of the solar system in attractive style and with smooth and logical argument. Describes the tools and methods of the astronomer. Discusses the known planets with special emphasis on the unique characteristics of the earth. Probability of life on other planets is treated with caution. Answers questions most frequently asked by alert junior high school students. Recommended as a guidebook and as junior high level supplementary reading.

State Curriculum Guides in Science, Mathematics, and Modern Foreign Languages, A Bibliography. E. Anne Putnam and Ralph P. Frazier. 28p. 25¢. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D.C. 1960.
Lists curriculum guides in subject-matter areas mentioned in title from each of the fifty states. Useful to the science educator and to the science teacher working on curriculum. Many of the titles are annotated. Complete, current listing.

Junior Science Book of Flying. Rocco V. Feravolo. 64p. $2.25. The Garrard Press, Champaign, Ill. 1960.
A thorough treatment of the principles of flight and control of aircraft for the young reader. Suggestions for numerous activities demonstrating lift, drag, thrust, and jet propulsion are clarified through pictures and diagrams.

Junior Science Book of Stars. Phoebe Crosby. 64p. $2.25. The Garrard Press, Champaign, Ill. 1960.
An attractively illustrated and interestingly written book for the young astronomer. Presents accurate information on the earth, moon, sun, and stars for primary grade children. Introduces new vocabulary and encourages direct observation of astronomical phenomena.

Junior Science Book of Electricity. Rocco V. Feravolo. 60p. $2.25. The Garrard Press, Champaign, Ill. 1960.
A fairly comprehensive treatment of static and current electricity for the upper primary and early intermediate grades. The numerous suggestions for activities and illustrations stimulate investigation. Topics covered include fuses, dry cells, short circuits, and electromagnets, among others.

The Tale of a Pond. Henry B. Kane. 114p. $3. Alfred A. Knopf, Inc., New York 22, N. Y. 1960.
This is a nature study book in which the life of a pond through a full year's cycle is vividly re-enacted. The story of the plants, animals, birds, and insects in and about the pond is told in a very picturesque manner through the watchful eyes of a little boy. Chapter headings include: Break of Day, Around the Sun, Family Story, Tall from the Mud, Dragon of the Pond, Net Returns,

Unlikely Trappers, Scales and Armor, Strange Doings, Stalkers on Stilts, and Voice of the Night. Excellent descriptions of biological concepts. The drawings and photographs are comparable to the excellence of the text. Book provides a fine reference for the sixth grade through junior high school.

Junior Science Book of Trees. Robert S. Lemmon. 62p. $2.25. The Garrard Press, Champaign, Ill. 1960.
An attractively illustrated and simply written story of trees for beginning readers. Functions of roots, stem, and leaves are discussed in relation to tree growth, and types and dissemination of seeds are briefly covered. Includes an introduction to tree identification, forest utilization, conservation, and ecology.

Junior Science Books of Beavers. Alexander L. Crosby. 64p. $2.25. The Garrard Press, Champaign, Ill. 1960.
The story of beavers and how they live written in an authoritative and simple fashion for younger readers. Contains attractive illustrations of beavers at work building lodges and dams and maps of beaver colonies. Some problems, history, and ecology are also discussed.

Sir Isaac Newton. W. Robert Houston and M. Vere Devault. 48p. $1.75. Steck Company, Box 16, Austin 61, Texas. 1960.
A picture biography of Sir Isaac Newton. Includes a simple concise explanation of his major contributions to science: Theory of Gravitation, Characteristics of Light and Color, and Laws of Motion. The application of laws to present scientific technology is also included. Contains a selection of simple experiments which would enhance student's understanding of principles presented. Worthy addition to the elementary school science library.

Growing Up with Science. First Edition. Marianne Besser. 218p. $4.50. McGraw-Hill Book Company, Inc., 330 West 42nd St., New York 36, N. Y. 1960.
Some new ideas in science motivation for everyone. The role of the parent-child team in scientific investigation is emphasized. Discusses how to guide your child in an era of scientific advancement. Includes ideas on answering children's questions about science, and resources for parents in guiding children's interests. Stresses the value of developing an early scientific vocabulary, mathematics, foreign languages, and books. Includes many interesting ideas and sources of additional materials for use in motivating scientific awareness.

Accelerators—Machines of Nuclear Physics. Robert R. Wilson and Raphael Littauer. 196p. 95¢. Published by Anchor Book, Doubleday and Company, Inc., Garden City, N. Y. Available to secondary school students and teachers through Wesleyan University Press, Inc., Columbus 16, Ohio. 1960.
Traces the historical development of high energy particle accelerators and describes the role of scientists who developed these machines. One can read with understanding the function of accelerators, such as the linear type, and the cyclotron, betatron, synchrotron, and the more modern accelerators. Some pages are devoted to natural products of cosmic accelerators known as cosmic rays. An excellent supplement for enriching high school physics.

Adventures in Algebra. Norman Crowder and Grace Martin. 350p. $3.95. Doubleday and Company, Inc., Garden City, N. Y. 1960.
A textbook addressed primarily to adult readers who have studied elementary algebra, but who perhaps have not understood it sufficiently. A variety of topics is considered, each intended to bring new insight for the reader. "Is there a largest prime?"—is one topic where the authors show the power of careful reasoning in an algebraic setting. Excellent reading for all prospective mathematics and science teachers.

Wheels. Alice Fleming. 176p. $3.75. J. B. Lippincott Company, East Washington Square, Philadelphia 5, Pa.
Many facts included. However, these are overshadowed by the theme's clarity in depicting the historical evolution of wheeled vehicles. Chapter titles indicate coverage: The Earliest Vehicles, The Widening World of Wheels, The Heyday of the Carriage, The Two-Wheeler, Trains, Urban Transportation, The Automobile, and Variety on Wheels. Title is misleading since little is said of wheels and nothing of their uses, other than transportation. Many fine illustrations. Excellent for general or supplementary social applications in junior high school science.

Paper. Jerome S. Meyer. 92p. $3. The World Publishing Company, 2231 West 110th St., Cleveland 2, Ohio. 1960.
A short but comprehensive treatment of paper and its importance to modern civilization. Well written and illustrated with photographs. Describes the many uses of paper and traces its history and manufacture. Explains the chemical and groundwood processes of paper manufacture and the production of paperboard for boxes and cartons. For readers of ten to twelve years.

Flight Facts for Private Pilots. Merrill E. Towers. 212p. Hardbound $5, Paperbound $3.50. Aero Publishers, Inc., 2162 Sunset Blvd., Los Angeles 26, Calif. 1960.
An excellent and interesting book explaining the "fundamentals of flying." Written especially for the student and private pilot. Sections on theory of flight, the airplane, navigation, weather, and instrument flying are included. The book is generously supplied with photographs and drawings, and contains a glossary of aeronautical terms. Material for this book was contributed by well-known aviation organizations.

First Men To The Moon. Wernher Von Braun. 96p. $3.95. Holt, Rinehart and Winston, 383 Madison Ave., New York 17, N. Y. 1960.
A completely fascinating story of the first trip to the moon written by the man who knows best what will take place. An exciting narrative from the time the two astronauts enter the space capsule on earth until they return; with an interval of several days spent in collecting designated scientific data on the moon. It does not read as fiction, but it makes you live a scientific trip. In the margins Dr. Von Braun clears up many definitions new to the laymen. Recommended for fifteen-year-olds or adults.

The Future of Man. P. B. Medawar. 128p. $3. Basic Books Inc., 59 Fourth Ave., New York 3, N. Y. 1960.
Chapter headings include: The Fallibility of Prediction; The Meaning of Fitness; and The Future of Man. The book was written to answer two questions, namely; (1). Is there any real reason to suppose that advances in medicine and hygiene are undermining the fitness of the human race? (2). Is man potentially capable of further evolution, or must we suppose that his evolution has now come to an end? The concepts of genetics and evolution are given somewhat clearly, however, a small knowledge of genetics is helpful in following the author's suppositions and conclusions. A highly interesting book from a biological standpoint and should be an excellent addition to the teacher's reference shelf. For use in advanced biology classes.

There Stand the Giants: The Story of the Redwood Trees. Harriett E. Weaver. 70p. $2.95. Lane Book Company, Menlo Park, Calif. 1960.
A Sunset Junior Book. Contents include age, discovery, size, the two types of redwoods (Coast and Sierra), lumbering history, uses,

and conservation of redwoods. Beautiful photographs (from fossil to forest). Maps and simple diagrams give biological information about trees in general. Size of trees and cones are compared with objects familiar to children. Growth of tree paralleled with major historical periods. Conservation of trees emphasized. Ends with descriptions of parks. The book is complete, simple, and well balanced. Recommended supplementary reading for beginning biology.

The Trachtenberg Speed System of Basic Mathematics. Translated and Adapted by Ann Cutler and Rudolph McShane. 270p. $4.95. Doubleday and Company, Inc., 575 Madison Ave., New York 22, N.Y. 1960.
The translators have made available to the American public, and especially to teachers of mathematics, the work of a genius who "developed" certain short cuts to mental arithmetic computations. Jakow Trachtenberg, while imprisoned in a German concentration camp, kept himself alive and sane by letting his mind play with the number system which he used as an engineer and applied mathematician. The results were an "organized" set of rules which one can memorize and use to do rapid mental calculations in fundamental operations. Although "there are no multiplication tables" as such, we find that all of the operations require the user to know what the multiplication tables are. Certainly to "understand" the rules, one must eventually have more "sophistication" than the jacket publicity claims. The translation is accurate, but the claims concerning prerequisites for using the system might be overenthusiastic. The volume will be a valuable one for enrichment ideas of a knowledgeable teacher of arithmetic and mathematics.

Introduction to Space Age Astronomy. John M. Cavanaugh. 170p. $2.75. Educational Services, 1730 Eye St., N.W., Washington 6, D.C. 1961.
A detailed, descriptive, non-mathematical treatment of astronomy, designed for a text and workbook in the secondary schools, as well as a supplementary aid in college introductory astronomy courses. The main topics include chapters on The Earth, The Moon, The Sun, The Sun's Family, Time and the Calendar, Eclipses, and The Universe. Throughout the book descriptions of specific topics are kept brief. A discussion of each of the planets is given and included is a table of such data as size, mass, density, period of rotation, gravity, and escape velocity. Fully illustrated with clear line drawings.

The second section is a workbook which specifically follows the chapters of the text. The exercises consist of a series of "fill-in-the-blanks" questions. A crossword-puzzle technique is used in the latter exercises.

"What Is" Series.
Benefic Press, Publishing Division of Berkley-Cardy Company, 1900 North Narragansett, Chicago 39, Ill. 1960.
A 25-per cent discount to schools and libraries; transportation and insurance charges added when 5 or more titles are ordered. Each book 48 pages. List price, $1.60, Net price $1.20.

What Is a Cow? Gene Darby.
Good discussion of an animal no longer familiar to boys and girls as a result of urbanization. Should be useful with very small children. Discusses production of milk and its distribution without discussion of pasteurization.

What Is Light? Theodore W. Munch.
Covers light as a form of energy and sources of light. Discusses transmission, reflection, refraction, and absorption. Discusses vision, nature of color, and the conversion of light energy to other forms of energy. Good one-page dictionary of terms included.

What Is a Frog? Gene Darby.
Describes frogs from egg through adult. May be simplified at the expense of factual accuracy. Example: text states that frog cannot stay under water long, but describes hibernation of frog in mud. Somewhat anthropomorphic.

What Is a Tree? Gene Darby.
Discusses parts, structure, and function of trees. Shows a variety of forest products. Some illustrations and ideas are misleading.

What Is a Fish? Gene Darby.
Describes characteristics of form, structure, and function of fish. Some portions may be over-simplified. Gives child an introduction to oddities in the class.

What Is an Atom? Gabriel Reuben and Joseph DiStephano.
An elementary approach to types of atoms telling their size and make-up, how they are studied, atomic radiation, fission and fusion, and nuclear power. Colorful pictures. Picture dictionary. For intermediate grades.

What Is Air? Albert Piltz.
Observations to show we live in an ocean of air which is real, exerts pressure, is necessary to life, changes the earth's surface and works for man. Appropriately illustrated. Picture dictionary. For upper primary or lower intermediate grades.

What Is Gravity? Fred M. King.
Tells how gravity causes weight, falling, earth changes. Timely discussion of importance of gravity to solar system, satellites, and space travel. Explanatory illustrations. Picture dictionary. Intermediate level.

What Is a Magnet? Gabriel Reuben and Gloria Archer.
Observations of magnetic effects, types of magnets, uses of magnets, and cause of magnetism. Illustrations to clarify discussions. Picture dictionary. Intermediate level.

What Is a Season? Gene Darby.
Describes many changes as each season progresses and how the seasons make up a year. Illustrated to follow chosen subjects through four seasons. Primary level.

What Is a Plant? Gene Darby.
Observes plants from a child's viewpoint, what they are, how they grow, how they change, kinds of plants, and their uses. Ample illustrations. Primary grades.

What Is a Solar System? Theodore W. Munch.
A book giving detailed information on: size and make-up of our solar system; its planets, moons, meteors, and their behavior; and the universe.

What Is Electricity? B. John Syrocki.
An explanation of static and current electricity, giving details of: its production, physical make-up and behavior, usage, dangers, as well as information on batteries, switches, fuses, and insulators.

What Is Sound? Gabriel A. Reuben.
An explanation of sound; its origin, behavior under different conditions, its means of travel, its usefulness to man, its qualities, and a brief explanation of sound in relation to man's voice and ear.

What Is a Rocket? Theodore W. Munch.
Covers description, driving force, types of fuel, guiding systems, uses, and rockets in space. An excellent book for the elementary science library.

What Is a Bird? Gene Darby.
This book gives an elementary description of the life cycle of birds. It would be a valuable addition to the elementary science classroom.

What Is a Rock? B. John Syrocki.
This book covers the origin, economic importance, and degradation of igneous, sedimentary, and metamorphic rocks. It would be a worthy item for the elementary library.

What Is a Machine? B. John Syrocki.
A very readable and informative book on the six simple machines. It could be re-read several times by the interested intermediate grade student. Interesting one-page picture dictionary of machines included.

What Is Chemistry? Daniel Q. Posin.
The material is written at a high level for elementary children using such terms as the periodic table of the elements, neutron, electron, proton, and nucleus. Electron exchange is mentioned. Teacher must be well-versed in chemistry. Appropriate for science oriented pupil of upper elementary grades.

What Is a Star? Daniel Q. Posin.
A fascinating book on stars for the elementary grades. A wide range of topics is introduced along with a few facts pertaining to each topic. Topics such as what is a star, where did it come from, how we know they are there, are discussed and expertly illustrated. The science-interested fourth grader could profit from this book.

Tony's Birds. Millicent E. Selsam. 64p. $1.95. Harper and Brothers, 49 East 33rd St., New York 16, N.Y. 1961.
A primary level story of a young boy who learns to know birds through his father's help. The book emphasizes the observation, discovery, and reasoning approach to learning. It also guides the young reader in the proper use of a bird identification book. Useful to adults as well.

PROFESSIONAL READING

"The Cromwell Current." By John A. Knauss. *Scientific American,* 204:105. April 1961. A recently discovered current ranks among the greatest of the ocean currents. It flows in an easterly direction along the equator beneath the surface of the Pacific Ocean. Currents in the ocean are due to horizontal pressures of waters of different depths and to the effect of the rotation of the earth. (See April *TST*, p. 49.)

"Lee Waves in the Atmosphere." By R. S. Scorer. *Scientific American,* 204:124. March 1961. Wind blowing across mountains produce waves in the atmosphere. Characteristic cloud forms indicate the presence of these invisible waves. Cloudscapes are thus an indication of the landscape beneath.

"Atomic Energy Research in the Life and Physical Sciences—1960." U. S. Atomic Energy Commission, Washington, D. C. January 1961. First of a series of yearly special reports of the Atomic Energy Commission devoted to findings and activities in basic research. Specifically includes biological, medical, environmental science, and radiation detection research of the life sciences program and physics and mathematics, chemistry, metallurgy and materials, and controlled thermonuclear research in the physical sciences program. Single copies are available for $1.25 through the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

"Automation in Education. Machines and Men as Teachers and Learners." Bureau of Publications, Teachers College, Columbia University, 525 West 120th St., New York 27, N. Y. 1960. A reprint of three articles from the December issue of the *Teachers College Record.* Titles include: "Two Models of a Student" by Eugene Galanter, "A Do-It-Yourself Kit for Programmed Instruction" by Ernst Z. Rothkopf, and "The Instructional Gestalt: A Conceptual Framework" by Laurence Siegel. Copies at 50 cents each may be ordered from the Bureau of Publications.

"Yearbook 1961. Balance in the Curriculum." Association for Supervision and Curriculum Development, National Education Association, 1201 Sixteenth St., N. W., Washington 6, D. C. In an effort to represent the objectives of workers in the curriculum field and to determine effective criteria for establishing a balanced curriculum, the ASCD has published a collection of essays written by twelve educators. The Yearbook is not intended to be definitive; rather it is a discussion of the contributors' conceptions of curriculum balance and emphasis. Available for $4.50 from the ASCD.

"Science in Antarctica." National Academy of Sciences-National Research Council, Washington 25, D. C. 1961. Surveying geophysical, biological, and medical research in Antarctica, this two-part report appraises current scientific knowledge of the area and also considers desirable objectives for future research programs. Part I, The Life Sciences in Antarctica, deals with Antarctic mammals, fishes, fresh water and marine algae, lichens, birds, bryophytes, marine invertebrate fauna, and other subjects including man in Antarctica. Part II, The Physical Sciences in Antarctica, concentrates on meteorology, oceanography, glaciology, seismology, geodesy, cartography, magnetism, geology, and ionospheric, cosmic ray, auroral, and solar studies. A limited number of copies, $1.50 for each Part, are available from the National Academy of Sciences, 2101 Constitution Ave., N. W., Washington 25, D. C.

"Guidance for the Academically Talented Student." National Education Association Project on the Academically Talented Student and the American Personnel and Guidance Association. 1961. Report on the conference program of guidance counselors and educators seeking to locate and give opportunity for development to academically talented students in public schools. Emphasis is given to such points as early identification, motivation, and attention to the "creative" student as distinguished from the high achiever. An appendix of student projects and their sources is included. Copies, $1 each, may be ordered from the NEA, 1201 Sixteenth St., N. W., Washington 6, D. C.

"Human Variability and Learning." Association for Supervision and Curriculum Development, National Education Association, 1201 Sixteenth St., N. W., Washington 6, D. C. 1961. Compilation of reports presented at the fifth curriculum institute on the learning process. Suggests that the creative individual is not readily recognized through the present IQ testing methods. Studies show not only that a distinct difference exists between the "IQ type" and the "creative type," but that "gifted" types are found in other fields, such as planning, evaluation, and communication. Various influences on the learning process for the individual and groups are also discussed. Copies, available for $1.50 each, may be obtained from the ASCD.

"A Report on the Status of Advanced Biology in Large Secondary Schools of the United States." *The American Biology Teacher,* 23:7. January 1961. The number of advanced biology courses has been increasing steadily since 1952. A majority of these use more than one college text as primary textbooks for the course, supplementing these with other college reference works. Seventy-three per cent of the teachers of these courses have taken college biological science within the past five years. Tables 7 through 15 indicate the degree to which topics of biology are studied in these biology courses.

"Teaching Concepts of Modern Astronomy to Elementary-School Children." *Science Education,* 45:54. February 1961. This study is one phase of an attempt to prepare curriculum materials which are in keeping with current scientific developments. It opens to question the popular theory that content selection should be based on personal and social needs as a result of the finding that children can learn astronomy concepts not related to their lives.

"Independent Activities for Creative Learning." By Helen Fisher Darrow and R. Van Allen. *Practical Suggestions for Teaching*, No. 21, Edited by Alice Miel. 110p. $1.25. 1961. Bureau of Publications, Teachers College, Columbia University, New York City. This publication is designed to aid the classroom teachers who aim to place a greater emphasis on creative self-expression. Effective ways of organizing the classroom for independent activities and for promoting creative thinking are given. Four main chapters are Action for Independence, Organizing the Daily Program for Independent Activities, Independent Activities which Promote Creative Learning, and Using Skills Through Self-Expression. Contains specific illustrations, tables, and many practical suggestions which are inexpensive as well as readily available in most classrooms. Excellent presentation of teaching techniques.

"Science. Grades 1-9." This is the first of a series of leadership bulletins prepared by the Texas Education Agency designed to assist local schools in the development of curriculum plans recommended under the 1958-59 Texas Curriculum Studies. The guide introduces a list of natural science principles for grades 1-9, in the areas of physical, biological, and earth sciences and shows how they can be incorporated into useful teaching units. Presented in the form of teaching outlines, this material is directed at developing skills which pupils may continue to apply throughout life, and is intended to encourage science teaching at the listed grade levels. February 1961.

For comments or information on the series write to Calvin D. Hibler, Assistant Director, Division of Program Development and School Accreditation, Texas Education Agency, Austin, Texas.

AUDIO-VISUAL AIDS

Science for Science—The Story of the Scientific Laboratory Furniture Industry. A new 35-mm color filmstrip in sound produced by the research and development committee of the laboratory equipment section of the Scientific Apparatus Makers Association. The processes of planning and building school scientific laboratories are shown. From the initial steps in the science-room planning, the viewer is shown the industry's vast engineering, design, and drafting department resources, and demonstrations of actual production operation in the building of laboratory furniture. Interested school executives, school board members, science educators, and citizen groups may write for additional information to: Laboratory Equipment Section, Scientific Apparatus Makers Association, 20 North Wacker Drive, Chicago 6, Ill.

Industrial Applications of Radioisotopes. A semi-technical 16-mm film surveying the current widespread uses of radioisotopes in American industry. The film story demonstrates examples of industrial uses of isotopes for thickness, density, and level gauging, radiography, and tracing. Specific applications of rubber products, sheet metal, plastics, paper, nylon, food and containers, ship-building, oil, automobiles, and future potential uses of isotopes are shown. Basic principles of radioisotopes are explained through animation. Though of interest to a broad audience, the film is designed to acquaint industrial management with the versatility, the economy and ease with which radioisotope techniques can be adapted to plant requirements. 57 min. Color. Free loan or purchase. 1961. Prints are available for purchase from the Army Pictorial Center, 35-11 35th Ave., Long Island City 1, N. Y. Information on purchase of prints by private or government agencies, including cost, may be obtained from the Audio-Visual Branch, Office of Public Information, U.S. Atomic Energy Commission, Washington 25, D.C.

Science of Light. A film correlated with the Heath Science Series. As an illustration of the concept, a young boy is shown as he asks himself questions about light and then tries to answer the questions. These involve the nature of sight, the speed of light, reflection from a variety of surfaces, and absorption and heating effects. A simple explanation of refraction is included. Differences between bodies which are opaque, transparent, and translucent are demonstrated by the employment of animation, photomicrography, and visualization. Recommended as an introduction to light for science classes in the intermediate grades. 11 min. Color $110, B&W $60. 1960. Churchill-Wexler Film Productions, 801 North Seward St., Los Angeles 38, Calif.

Life in the Woodlot.* This is an excellent film on introductory ecology. It weaves in a story of an owner of a woodlot demonstrating his knowledge of changes, both seasonal and long-time, which have occurred in the woodlot. The pyramid of numbers is well portrayed through discussion of relationships such as predation and competition. The pyramid develops with these steps: the plants, insect grubs, young fledgling grouse chick, snake, hawk, and man. Competition among plants for light is illustrated. Long-time conversation practices are illustrated. The film shows the forest as an esthetic resource as well as a commercial resource. For the alert biology teacher, this film would provide an excellent treatment of the ecology of a hardwoods woodland. For the unit on conservation, it would serve the purpose of stimulating a real interest in ecological relationships and explain the foundation part they play in good conservation practices. Film is recommended for high school biology and for use in instructing lay groups in many aspects of conservation. 17 min. Prices undetermined but in the following range: Color $190, B&W $100. 1960. National Film Board of Canada, 680 Fifth Ave., New York 19, N. Y.

***NOTE: An earlier review of this item (See April TST, page 69) did not carry accurate data, and is, therefore, revised above.**

NOTICE TO READERS

NSTA members receiving Packet No. 56 will have by now read about the free materials listed in the March 1961 copy of the NSTA News Bulletin. On page 4 of the News Bulletin, the following item "Closing the Gap" was listed as available from the Scientific Apparatus Makers Association, 20 North Wacker Drive, Chicago 6.

We have been advised that this item is OUT OF PRINT and NO LONGER AVAILABLE. Since no reprinting has been planned, it is suggested that no requests be forwarded to SAMA for this booklet.

The Two Cultures and the Scientific Revolution. This thirty-minute, long-playing record, representing a review of the book by C. P. Snow, was produced for the Young Book Reviewers' radio program, Station WMCA, New York City. Participating student panelists, a guest, and a moderator chose important points from Sir Charles' volume for discussion and debate. The conflict between scientists and humanists is well presented.

The recording serves as a follow-up to the book. In fact, this reviewer questions the advisability of presentation of the record alone without previous reading of the book. Recommended for the more alert senior high school students, grades 11 and 12. 30 min. Price not quoted. 1960. Requests for a copy of the record should be addressed to Cambridge University Press, 32 East 57th St., New York 22, N. Y., Attention: Science Department. (See Review of Snow's book on page 51.)

Mystery of Time. An excellent film which uses the high-speed camera to alter time dimension. The photography is fine, and the commentary well done. Slow-motion photography is utilized to lengthen time sequence in demonstrating an arrow striking an egg and a drop of milk striking a liquid surface. One feature adds interest by speeding events of a long period of time into a few minutes. Relativity and the interrelationships of time, space, and matter are simply, yet dramatically portrayed, by showing horizontal and vertical contraction. The audio portion is used to good advantage in demonstrating lowering of voice pitch and slower heartbeat at high acceleration in approaching the speed of sound. Recommended for high school physical science classes. It would also serve as an informational film for the general public. 40 min. Color $340. 1960. Moody Institute of Science, 11428 Santa Monica Blvd., Los Angeles 25, Calif.

Weather Scientists. One of the films in the New United World Elementary Science Series. Does an excellent job of showing how the U.S. Weather Bureau functions in predicting weather. Shows how weather data is collected from a variety of sources, including local offices, regional centers, airplanes, and ships at sea. Illustrates how all data collected are processed by electronic computers. Photography of technicians at work plotting weather maps is excellent. Interpretation of maps also well presented. Numerous weather instruments are shown and their operation and function explained. A portion of the film treats weather's influence on our daily lives. Highly recommended for general science grades 6-9. 13½ min. Color $135. 1960. United World Films, Inc., 1445 Park Ave., New York 29, N. Y.

Principles of Chromatography. A film demonstrating the technique of separating materials by chromatography. Four different methods are clearly illustrated and described: separation by absorption, partition, the use of paper, and an interesting two-way method. This British film should be of particular interest to advanced high school chemistry students because the subject is clearly explained and can be easily adapted for projects. 20 min. Color $190. 1960. Contemporary Films, 267 West 25th St., New York 1, N. Y.

The True Book Filmstrips of Physical Science. A set of six filmstrips illustrating a variety of topics covered in elementary science. Recommended for upper primary and early intermediate grades. Titles: Air Around Us, Deserts, Moon, Sun and Stars, Oceans, Rocks and Minerals, and Seasons. May be used with other series of True Books or as an independent unit of study. Color. Set $28.50, $4.75 each. 1960. Childrens Press, 300 South Racine Ave., Chicago 7, Ill.

The True Book Filmstrips of Biological Science. A set of six filmstrips designed for early and middle elementary grades to enhance the study of living things. Titles are: Dinosaurs, Farm Animals, Pets, Reptiles, Tropical Fishes, and Your Body and You. Colorful pictures and drawings are of interest to children, and the captions are suitable for the beginning independent reader. May be used separately or coordinated with other True Books. Color. Set $28.50, $4.75 each. 1960. Childrens Press, 300 South Racine Ave., Chicago 7, Ill.

Marshes of the Mississippi. This fine natural history film takes the viewer on a trip through the wastelands of the Mississippi Delta and shows how new land is being formed at the mouth of the river. Excellent wildlife photography. Includes many details about alligators, turtles, mink, otters, raccoons, muskrats, nutria, and other forms. A professional trapper, preparing for the harvest of pelts, is shown. Film points out how the marshes are used as wintering grounds for ducks and geese. The com-

mentary gives a good, objective lesson in conservation. Has general appeal and is also recommended for ecology and conservation units in junior and senior high school science and biology. 12 min. Color $120, B&W $60. 1960. Avalon Daggett Productions, 441 North Orange Drive, Los Angeles 36, Calif.

The True Book Filmstrips of Natural Science. Six filmstrips of general interest to children in primary and early intermediate grades. Recommended for independent showing or in conjunction with other True Books. Titles are: Animal Babies, Animals of Sea and Shore, Birds We Know, Insects, Plants We Know, and Trees. The sequences are good. Suitable for reading at upper grade levels. Color. Set $28.50, $4.75 each. 1960. Childrens Press, 300 South Racine Ave., Chicago 7, Ill.

The Face of the High Arctic. An excellent film introducing the viewer to an unfamiliar land. Describes changes in the Arctic from a land of temperate climate to today's barren wastes. Photographs clearly illustrate evidence for these changes, including that in coal strata and imprints of marine creatures. Also shown are evidences of past and present glaciation. This film illustrates the value of a medium in bringing to a viewer an

experience he might not have had. The locale is the Queen Elizabeth Islands in the Canadian Arctic. Recommended for earth science classes in particular. Useful also in geology units in general science, and in geography. Appeal for students from grade six through college. 13 min. Color $150, B&W $75. 1960. National Film Board of Canada, 680 Fifth Ave., New York 19, N. Y.

Life in the Ocean. Shown in color are the following plants and animals: diatoms, seaweed, sea anemone, sea fan, sea star, sea urchin, sea cucumber, sea worm, cowrie, sea slug, nudibranch, shore crab, fishes, hornshark, bass, sea horse, turtle, sea lion, and porpoise. The excellent photography shows the external structures in operation, such as the motion of the tube feet of the starfish, opening and closing of the mouth of the sea urchin, contraction of the sea cucumber when touched, movement of the tentacles and mouth in mollusks, use of pincers by the shore crab, intelligence of the porpoise, etc. Since most of the pictures were taken in an oceanarium, the animals are not in their natural habitat. The film is suitable for upper elementary and junior high school students in nature study or science. The film holds pupil interest well and presents many possibilities for further discussion. Color $160, B&W $85. 1960. Film Associates of California, 11014 Santa Monica Blvd., Los Angeles 25, Calif.

APPARATUS & EQUIPMENT

The Variable Phase Wave Generator Kit, No. 3100. This is a device for producing out-of-phase, point-source ripples in the ripple tank furnished by this Company. The generator consists of a baseboard, to which a small motor with a double-ended shaft is attached, and an eccentric drive apparatus for each of two "pop-pearl" point sources. The drives involve spring clothespins and an arrangement of brass sleeves rotating around a brass-tube shaft. They are independently adjustable by rotating the wooden cams on the motor shaft, thus providing the phase variation. Minor difficulty may be experienced in assembly because of misplaced holes in one precut wooden part. (The holes were redrilled and the assembly was completed with no further difficulty.) The producers indicate that this is being corrected. The base, about two cm thick, permits the generator to rest on the bottom of the ripple tank with the motor out of the water and the point sources adjusted to contact the water. In this device, as in the ripple tank, wooden parts should be waxed or varnished. Physical Science Study Committee equipment. One unit is recommended for each pair of students. In general, the device is

simple and should work effectively when it is properly adjusted and the vibration defect is corrected. Macalaster Bicknell Company, 253 Norfolk St., Cambridge 39, Mass.

Van de Graaff Generator. A good model, 17 inches high, of a commonly used static electricity generator. This one has an advantage in that both the aluminum top and bowl-shaped base can be lifted to show moveable parts. The insulating column between top and base are constructed of unbreakable vinyl plastic. The generator has a potential of 200,000 volts. Extra rubber belts are provided. The construction is simple and has been found satisfactory with repeated hard use. Meets specifications of NDEA-CCSSO Purchase Guide. $39.50. Edmund Scientific Company, 101 East Gloucester Pike, Barrington, N. J.

Space Kit. A comprehensive kit which can contribute much to the study of satellites, their orbits and outer space. Contains maps, charts, guidebooks, and two space slide rules. The slide rules are plastic and well constructed. Directions for the kit are clear except for the use of the satellite equatorial angle slide rule. Recommended for junior and senior high school. $4.95. 20 per cent discount to schools. 1960. Space Research Distributors, Inc., 208 Commercial Building, Avon Lake, Ohio.

The Ripple Tank Kit, No. 2400. The ripple tank may be set up according to instructions contained in the kit and used to demonstrate experiments on wave phenomena in water, as described in the Laboratory Guide to the Physical Science Study Committee (D. C. Heath and Company, 1960). Equipment provided consists of an assembled tank, materials for constructing the wave generator, dampers, paraffin blocks, and a glass plate. The tank, made of aluminum (extrusion "picture frame") with a glass bottom, should be filled with water and allowed to stand for about twenty-four hours. Although no supports for the tank are included in the kit, four ring stands will serve the purpose. The wave generator consists of a small motor with an eccentric fly wheel, held to a wooden bar by a spring clothespin. The bar, suspended by two rubber bands from an overhead support, forms the plane wave generator. Point-source ripples are formed by inserting L-shaped metal rods in the bar and contracting the water with plastic balls ("pop pearls" will do) placed at either end of the rods. A small rheostat and wire are included. Wave frequency is variable over an adequate range, using a 1½-volt dry cell as a power source. Surfaces of the wooden parts are unfinished and should be waxed or varnished before use to prevent absorption of water. This reviewer found that the tank and wave generator operated satisfactorily when tested. Certain modifications might be made to suit individual preference, but the apparatus will perform, by following instructions, just as it is assembled from the kit. $14.64. Macalaster Bicknell Company, 253 Norfolk St., Cambridge 39, Mass.

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